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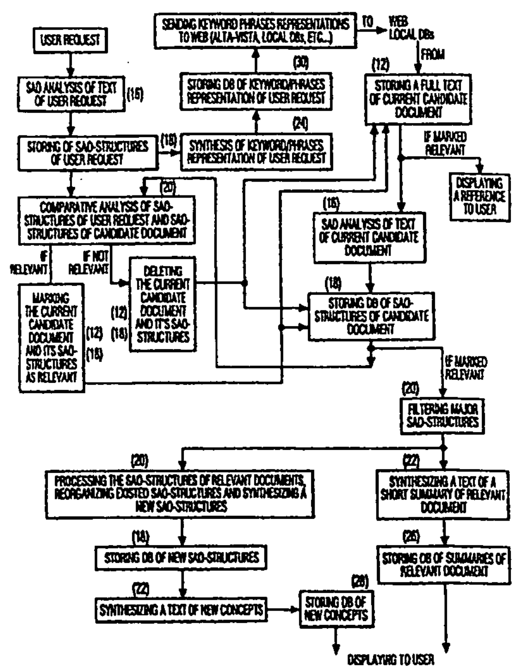
With international search report.

(54) Title: DOCUMENT SEMANTIC ANALYSIS/SELECTION WITH KNOWLEDGE CREATIVITY CAPABILITY

(57) Abstract

A computer based software system and method for semantically processing a user entered natural language request to identify (16) and store (18) linguistic subject-action-object (SAO) structures, using such structures as key words/phrases (24) to search (30) local and Web-based databases for downloading (12) candidate natural language documents, semantically processing candidate document texts into candidate document SAO structures, and selecting and storing only relevant documents whose SAO structures include a match with a stored request SAO structure. Further features include analyzing relationships among relevant document SAO structures and creating new SAO structures (20) based on such relationships that may yield new knowledge concepts and ideas for display to the user and generating and displaying natural language summaries (22, 26) based on the relevant document SAO structures.



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TITLE: DOCUMENT SEMANTIC ANALYSIS/SELECTION WITH KNOWLEDGE CREATIVITY CAPABILITY

REFERENCE TO PRIORITY APPLICATION:

This application claims the benefit of U.S. Provisional Application No. 60/099,641, filed September 9, 1998.

BACKGROUND:

The present invention relates to computer based apparatus for and methods of semantically analyzing, selecting, and summarizing candidate documents containing specific content or subject matter.

Computer based document search processors are known to perform key word searches for publications on the Internet and World Wide Web. Today, information owners and service providers are adapting their data bases to individual tastes and requirements. For example, Boston based Agents, Inc. offers over the Web personalized newsletters for music fans such that classical music lovers are blocked from receiving Rap music ads and vice-versa. KD, Inc. of Hong Kong has developed a system that takes into consideration words similar by sense while searching the Web. Today the user can download 10,000 papers from the Web by typing the word "Screen". The search system designed by KD, Inc. asks the user whether he/she is seeking papers related to Computer Screen, TV Screen or Window Screen. In this case, the number of unrelated

papers will be drastically reduced.

Software based search processors are able to remember requests of single user and to conduct personalized non-stop searches on the Web. So, when a user wakes up in the morning he/she finds references and abstracts of several new Web papers, related to his/her area of interest. In 1997, practically all fundamental technical publications, journals, magazines, as well as patents of all industrial countries became available on the Web, i.e. available in electronic format.

Although key word searching the Web affords the user great value, it also has created and will continue to create substantial problems adversely affecting this value. Specifically, because of the enormous amount of information available on the Web, key word search processors produce too much downloaded information, the vast majority of which is irrelevant or immaterial to the information the user wants. Many users simply give up in frustration when presented with several hundred articles in response to what the user considered a request for only those few articles related to a specific request.

This problem is also experienced in the technical fields of science and engineering, particularly since there is a growing number of libraries, government patent offices, universities, government research centers, and other adding vast amounts of technical and scientific information for Web access. Engineers, scientists, and doctors are overwhelmed with too many articles, papers, patents and general information on the topic of interest to them. In addition, the user presently has only two choices when examining a download article to determine its relevance to the users project. He/she can either read the authors abstract and/or scan various sections of the full article to determine whether or not to

save or print-out that specific document. Since the author's abstract is not comprehensive, it often omits the reference to the specific subject matter of interest to the user or treats this subject matter in an incomprehensive manner. Thus, scanning the abstract and scanning the full article may have little value and require an inordinate amount of user time.

Various attempts purport to increase the recall and precision of the selection such as U.S. Patents Nos. 5,774,833 and 5,794,050 incorporated here by reference, however, these methods simply rely on key word or phrase searching with various techniques of selection based on variations of the key words, or purported understanding of textual phrases. These prior methods may improve recall but may still requires too much physical and mental effort and time to determine why the document was selected and what is the pertinent part. This results from the entire document of abstract being presented without summary or concept generation.

SUMMARY OF EXEMPLARY EMBODIMENT OF PRESENT INVENTION

A computer based software system and method according to the principles of the present invention solves the foregoing problems and has the ability to perform a non-stop search of all databases on the Web or other network for key words and to semantically process candidate documents for specific technological functions and specific physical effects so that only the very few prioritized or a single article meeting the search criteria is presented or identified to the user.

Further, the computer based software system in accordance with the principles of

the present invention captures these few highly relevant documents and creates a compressed, short summary of the precise technical physical aspects designated by the search criteria.

Another aspect of the present invention includes using the semantic analysis results of the selected documents to create new ideas of knowledge concepts. The system does this by analyzing the subjects, actions, and objects mentioned in the documents and re-organizing these representations into new and/or different profiles of such elements. As further described below, some of these reorganized sets of relationships among these elements may comprise new concepts never before thought of by anyone.

According to an aspect of the present invention, the method and apparatus begins with the user entering natural language text related to the task or concept for which the user desires to acquire publications or documents. The system analyzes this request text and automatically tags each word with a code that indicates the type of word it is. Once all words in the request are tagged, the system performs a semantic analysis that, in one example, includes determining and storing the verb groups within the first sentence of the request, then determining and storing the noun groups within that sentence of the request. This process is repeated for all sentences in the request.

Next, the system parses each request sentence with an heirarcal algorithm into a coded framework which is substantially indicative of the sense of the sentence. The system includes databases of various types to aid in generating the coded framework, such as grammar rules, parsing rules, dictionary synonyms, and the like. Once parsed sentence codes are stored, the system identifies Subject-Action-Object (SAO) extractions within

each sentence and stores them. A sentence can have one, two, or a plurality of SAO extractions as seen in the detailed description below. Each extraction is normalized into a SAO structure by processing extractions according to certain rules described below. Accordingly, the result of the semantic analysis routine performed on the request text is a series of SAO structures indicative of the content of the request. These request SAO structures are applied to (1) a comparative module for comparing the SAO structures of candidate documents as described below and (2) a search request and key word generator that identifies key words and key combinations of words, and synonyms thereof, for searching the Web internet, intranet, and local data bases for candidate documents. Any suitable search engine, e.g. Alta Vista, can be used to identify, select, and download candidate documents based on the generated key words.

It should be understood that, as mentioned above, key word searching produces an over-abundance of candidate documents. However, according to the principles of the present invention, the system performs substantially the same semantic analysis on each candidate document as performed on the user input search request. That is, the system generates an SAO structure(s) for each sentence of each candidate document and forwards them to the comparative Unit where the request SAO structures are compared to the candidate document SAO structures. Those few candidate documents having SAO structures that substantially match the request SAO structure profile are placed into a retrieved document Unit where they are ranked in order of relevance. The system then summarizes the essence of each retrieved document by synthesizing those SAO structures of the document that match the request SAO structures and stores this summary for user

display or printout. Users can later read the summary and decide to display or print out or delete the entire retrieved document and its SAO's.

As stated above, the SAO structures for each sentence for each retrieved document are stored in the system according to the present invention. According to the knowledge creativity aspect of the present invention, the system analyzes all these stored structures, identifies where common or equivalent subjects and objects exist and reorganizes, generates, synthesizes, new SAO structures or new strings of SAO structures for user's consideration. Some of these new structured or strings may be unique and comprise new solutions to problems related to the user's requested subject matter. For example, if two structures S1-A1-O1 and S2-A2-O2 are stored, and the present system recognizes that S2 is equivalent to or the synonym for or has some other relation to O1 then it will generate and store for the user's access a summary of S1-A1-S2-A2-O2. Of if the system stores an association between S1 and A2 it can generate S1-A1/A2-O1 to suggest improvement of O1 toward desired results.

Other and further advantages and benefits shall become apparent with the following detailed description when taken in view of the appended drawings, in which:

DRAWING DESCRIPTION:

Figure 1 is a pictorial representation of one exemplary embodiment of the system according to the principles of the present invention.

Figure 2 is a schematic representation of the main architectural elements of the system according to the present invention.

Figure 3 is a schematic representation of the method according to the principles of the present invention.

Figure 4 is a schematic representation of Unit 16 of Figure 2.

Figure 5 is a schematic representation of Unit 20 of Figure 2.

Figure 6 is a schematic representation of Unit 22 of Figure 2.

Figure 7 is a typical example of the user request text entered by user.

Figure 8 is a tagged and coded representation version of text of Figure 7.

Figure 9 is an identification of verb groups of the text of Figure 8.

Figure 10 is an identification of noun groups of the coded text of Figure 8.

Figure 11 is a representation of parsed hierarchy coded text of Figure 8.

Figure 12 is a representation of SAO extraction of the text of Figure 7.

Figure 13 is a representation of SAO structures of the extraction of Figure 12.

DETAILED DESCRIPTION OF EXEMPLARY EMBODIMENTS

One exemplary embodiment of a semantic processing system according to the principles of the present invention includes:

A CPU 12 that could comprise a general purpose personal computer or networked server or minicomputer with standard user input and output driver such as keyboard 14, mouse 16, scanner 19, CD reader 17, and printer 18. System 10 also includes standard communication ports 21 to LANs, WANs, and/or public or private switched networks to the Web.

With reference to Figures 1-6, the semantic procession system 10 includes a

temporary storage or data base 12 for receiving and storing documents downloaded from the Web or local area net or generated as a user request text with use of keyboard 14 or one of the other input devices. User can type the request, examples disclosed below, or enter full documents into DB 12 and designate the document as user's request. System 10 further includes semantic processor 14 for receiving the entire text of each document and includes a Subject-Action-Object (SOA) analyzer Unit 16 that tags each word of each sentence with a code type (such as Markov chain theory code). Unit 16 then identifies each verb group and noun group, (described below) within each sentence, and parses and normalizes each sentence into SAO structures that represents the sense of the sentence. Unit 16 applies its output to DB of SAO structures 18. SAO processor Unit 20 stores the request SAO structures and receives the SAO structures of each sentence of each document stored in Unit 18. Unit 20 compares the document SAO's to the request SAO's and deletes out those documents with no matches. The SAO structures of matched documents are stored back in Unit 18 or some other storage facility. In addition, Unit 20 analyzes SAO structures within a single document or with those of one or more other relevant documents, searches for relationships among S-A-O's and generates new SAO structures for user consideration. These new structures are stored in Unit 18 or some other storage facility in the system.

Unit 14 further includes natural language Unit 22 that receives SAO structures in table form and synthesizes structures into natural language form, i.e. sentences.

Unit 14 also includes keyword Unit 24 for receiving SAO structures and extracts key words and phrases from them and acquires their synonyms for use as additional key

words/phrases.

Database Units 26, 28, and 30 receive the outputs from Unit 14, generally as shown, for storing the natural language summaries of selected SAO structures as described below and the key words/phrases that form user request sent to search engines through port 21.

Unit 16 includes document pre-formatter 32 that receives full text of documents from Unit 12 and converts the text and other contents to a standard plain text format. Text coder 34 analyzes each word of each sentence of text and tags a code to every word which code designates the word type, see Fig 8. Various data bases designated 44 in Fig 4 are available to aid the Units of Unit 16. Following tagging, recognizer Unit 36 identifies the verb groups (Fig 9) and the noun groups of each sentence (Fig 10). Sentence parser 38 then parses each sentence into a hierarchical coded form that represents the sense of the sentence. Fig 11. S-A-O extractor 40 organizes the SAO's of each sentence into extracted table format (Fig 12). Then normalizer 42 normalizes the extractions into SAO structures as described above (Fig 13).

SAO processor 20 includes three main Units. Comparative Unit 46 receives SAO structures from database 18. One set of these structures originates from the user request text described above and other sets originate from the candidate documents. Unit 46 then compares these two sets looking for matches between SAO structures of these two sets. If no match results, then the candidate document and associated SAO's are deleted. If a match is identified then the document is marked relevant and ranked and stored in Unit 12 and its SAO structures stored in Unit 18. Unit 46 then compares all candidate documents

in sequence and in the same way as described.

Unit 20 also includes the SAO structure reorganizing Unit 48 to synthesize new SAO structures from different documents on the same matter and combines them into the new structure, as described above, and applies them to Unit 18.

Filtering Unit 50 analyzes every SAO structure of each document and blocks or deletes those not relevant to the SAO structures of the request.

Reference 52 designates some of the data bases available to aid sub-units of Unit 20.

SAO synthesizer Unit 22 (Figure 6) includes a Subject detector 54 for detecting the content of the subject for each received SAO structure. If S is detected then the SAO is fed to Unit 56 in which the tree structure of the verb group(s) is restored to natural language using grammar, semantic, speech patterns, and synonyms rules data base 66. Synthesizer 58 does the same for subject noun groups and synthesizer 60 does the same for object noun groups. Combiner 68 then organizes and combines these groups into a natural language sentence.

If S was not detected by Unit 54, the SAO structures are processed by synthesizer 62 to restore the verb group in passive form. Synthesizer 64 processes the object noun group for a passive sentence and combiner 70 to organize and combine the groups into a natural language sentence.

If SAO structures received by Unit 54 bear new structure markings, then combiners 68 and 70 apply their output to Unit 28 and if they were marked existing SAO structure, then units 68, 70 apply output to Unit 26. See Fig 3.

The salient steps to the method according to the principles of the present invention

are shown in Figure 3, where the number in the parenthesis refer to the Units of Figure 2 where the process steps takes place. A session begins with the user inputting a national language request which could be customized with the use of the keyboard or would be a national language document entered via one of the input devices shown in Figure 1. A typical user generates customized request as shown in Figure 7., System 10 Unit 14, then by first tagging each word with a type code (See Figure 8) then identifying the verb groups of each sentence (Figure 9) and noun groups of each sentence (Figure 10) then processing each sentence into an hierarchical tree (Figure 11) and then extracting the SAO extractions where all extracted words are the originals of the request (Figure 12). Then the method normalizes these words (modifies) each as each action is changed to its infinitive form. This, "is isolated" Figure 12 is changed to "ISOLATE", the word "to" being understood (Figure 13). It should be understood that not all attributes of the subject, action and objects appearing in Figure 11 are shown in Figures 12 and 13, but the system knows the full attributes associated with the SAO elements and these attributes are part of the SAO structure. Also, note in Figure 13, no subject is listed for the last action because is indicated pursuant to the planning rules. This absence does not affect the reliability of the overall method because all sentences of the candidate documents the include an A-O of Isolate-slides will be considered a matter regardless of the subject. The normalized SAO's are called herein as SAO structures. These users request SAO structures are stored and applied in two following steps (i) synthesis of key word/phrases of user request; (ii) a comparative analysis of SAO structure of each sentence of each candidate documents as described below.

The request SAO structure key words/phrases are stored and sent to a standard search engine to search for candidate documents in local databases, LANs and/or the Web. AltaVista™, Yahoo™, or other typical search engines could be used. The engine, using the request SAO structure key words/phrases identifies candidate documents and stores them (full text) for system 10 analysis. Next the SAO analysis as described above for the search request is repeated for each sentence of each candidate document so that SAO structures are generated and stored as indicated in Fig. 3. In addition, the SAO structures of each document are used in the comparative steps where the request SAO structures are compared with the candidate document SAO structures. If no match is found then the documents and related SAO structures are deleted from the system. If one or more matches are found then the document and related structures are marked relevant and its relevancy marked for example on a scale of 1.0 to 10.0. The full relevant document text is permanently stored (although it can later be deleted by user if desired) for display or print-out as user desires. Relevant SAO structures are also marked relevant and permanently stored.

Next System 10 filters out the least relevant SAO structures and uses the matched SAO structures of each relevant documents to synthesis into natural language summary sentences(s) the matched SAO structures and the page number where the complete sentence associated with the matched SAO structures appears. This summary is stored and available for users display or print-out as desired.

Filtered relevant SAO structures of relevant document(s) are analyzed to identify relationships among the subjects, actions, and objects among all relevant structures. Then

SAO structures are processed to reorganize them into new SAO structures for storage and synthesis into natural language new sentence(s). The new sentences may and probably some of them will express or summarize new ideas, concepts and thoughts for users to consider. The new sentences are stored for user display or print-out.

For example, if

S_1-A_1-O_1

S_2-A_2-O_2

S_3-A_3-O_3

and S_1 is the same as or a synonym of O_3 then S_3-A_3-S_1-A_1-O_1 is synthesized into a new sentence and stored.

Accordingly, the method and apparatus according to the present invention provides user automatically with a set of new ideas directly relating to user's requested area of interest some of which ideas are probably new and suggest possible new solutions to user's problems under consideration and/or the specific documents and summaries of pertinent parts of specific documents related directly to user's request.

Although mention has been made herein of application of the present system and method to the engineering, scientific and medical fields, the application thereof is not limited thereto. The present invention has utility for historians, philosophers, theology, poetry, the arts or any field where written language is used.

It will be understood that various enhancements and changes can be made to the example embodiments herein disclosed without departing from the spirit and scope of the present invention.

WE CLAIM:

Claim 1. A natural language document analysis and selection system comprising,

a general purpose computer having a monitor, a central processing unit (CPU), a user input device for generating request data representing a natural language request, and a communications device for communication with local and remote natural language document databases,

said CPU comprising (i) first storage means for storing the request data, (ii) a semantic processor for generating request subject-action-object (SAO) extractions in response to receiving request data, and (iii) SAO storage means for storing representations of the request SAO extractions.

Claim 2. A system as set forth in Claim 1, wherein said communication device conveys candidate document data to said CPU for storage in said first storage means, the candidate document data representing natural language document text,

said semantic processor generating candidate document SAO extractions in response to receiving candidate document data, and

said SAO storage means also storing representations of candidate document SAO extractions.

Claim 3. A system as set forth in Claim 2, wherein said semantic processor identifies matches between said representations of said request SAO extractions and said candidate document SAO extractions.

Claim 4. A system as set forth in Claim 3, wherein said semantic processor comprises means for marking as relevant candidate document data that includes at least one representation of candidate document SAO extraction that matches at least one representation of request SAO extraction.

Claim 5. A system as set forth in Claim 4, wherein said semantic processor comprises means for deleting stored candidate document data and stored representations of candidate document SAO extractions for those documents that have no representation of candidate document SAO extraction that matches a representation of request SAO extraction.

Claim 6. A system as set forth in Claim 3, wherein said semantic processor includes an SAO text analyzer having a plurality of stored text formatting rules, coding rules, word tagging rules, SAO recognizing rules, parsing rules, SAO extraction rules, and normalizing rules for applying such rules to the request data and candidate document data such that said representations of candidate document SAO extractions and of request SAO extractions comprise candidate document and request SAO structures, respectively.

Claim 7. A system as set forth in Claim 6 further comprising second storage means for storing request SAO structures and for applying SAO structures as key words/phrases to said communication device for application to document search engines on the WEB or local databases to cause downloading of candidate document data to the system.

Claim 8. A system as set forth in Claim 6 further comprising an SAO synthesizer for generating and storing for display on said monitor natural language summaries of marked documents in response to receipt of document SAO structures.

Claim 9. A system as set forth in Claim 6 further comprising an SAO synthesizer for analyzing relationships among subjects, actions, and objects among relevant and stored SAO structures and processing those SAO structures that have a relationship with at least one other SAO structure to generate a different SAO structure and storing the different SAO structure for display to the user.

Claim 10. A system as set forth in Claim 9 wherein said relationship comprises:

S_1-A_1-O_1

S_2-A_2-O_2

where S_1 synonym O_2

Then S_2-A_2-S_1-A_1-O_1.

Claim 11. In a digital data processing system including the World Wide Web and a general purpose computer having a monitor, a central processing unit (CPU), a user input device, and a communications device for communication with local and remote natural language document databases, the method of analyzing and selecting natural language documents comprising,

generating request data representing a natural language request,

storing the request data,

semantically processing the request data to generate request subject-action-object (SAO) extractions, and

storing representations of the request SAO extractions.

Claim 12. The method as set forth in Claim 11, wherein said communication device conveys candidate document data to said CPU, the candidate document data representing natural language document text,

storing the candidate document data,

said semantically processing including generating candidate document SAO extractions in relation to the candidate document data, and

storing representations of candidate document SAO extractions.

Claim 13. A method as set forth in Claim 12, wherein said semantically processing includes identifying matches between said representations of said request SAO extractions and said candidate document SAO extractions.

Claim 14. A method as set forth in Claim 13, wherein said semantically processing comprises marking as relevant candidate document data that includes at least one representation of candidate document SAO extraction that matches at least one

representation of request SAO extraction.

Claim 15. A method as set forth in Claim 14, wherein said semantically processing comprises deleting access to stored candidate document data and stored representations of candidate document SAO extractions for those documents that have no representation of candidate document SAO extraction that matches a representation of request SAO extraction.

Claim 16. A method as set forth in Claim 13, wherein said semantically processing includes applying a plurality of stored text formatting rules, noun and verb recognition rules, coding rules, word tagging rules, SAO recognizing rules, parsing rules, SAO extraction rules, and normalizing rules to the request data and candidate document data such that said representations of candidate document SAO extractions and representations of request SAO extractions comprise candidate document and request SAO structures, respectively.

Claim 17. A method as set forth in Claim 16 further comprising storing request SAO structures and applying SAO structures as key words/phrases to document search engines on the WEB or local databases to cause downloading of candidate document data to the CPU.

Claim 18. A method as set forth in Claim 16 further comprising generating and storing and displaying on said monitor natural language summaries of marked relevant documents in relation to relevant document SAO structures.

Claim 19. A method as set forth in Claim 16 further comprising analyzing relationships among subjects, actions, and objects among relevant and stored SAO structures, further processing those SAO structures that have a relationship with at least one other relevant and stored SAO structure, and generating a different SAO structure based on the said relationship, and

storing the different SAO structure and displaying the different SAO structure to the user.

Claim 20. A method as set forth in Claim 19 wherein said relationship comprises:

S_1-A_1-O_1 comprises one relevant and stored SAO structure

S_2-A_2-O_2 comprises a second relevant and stored SAO structure

where said relationship comprises S_1 synonym O_2

and the different SAO structure is

S_2-A_2-S_1-A_1-O_1 .

Claim 21. A method as set forth in Claim 19 wherein said relationship comprises:

S_1-A_1-O_1 comprises one relevant and stored SAO structure

S_2-A_2-O_2 comprises a second relevant and stored SAO structure

where said relationship exists between S_1 and A_2

and the different SAO structure is

S_1-A_1 /A_2-O_1

where / means alternate.

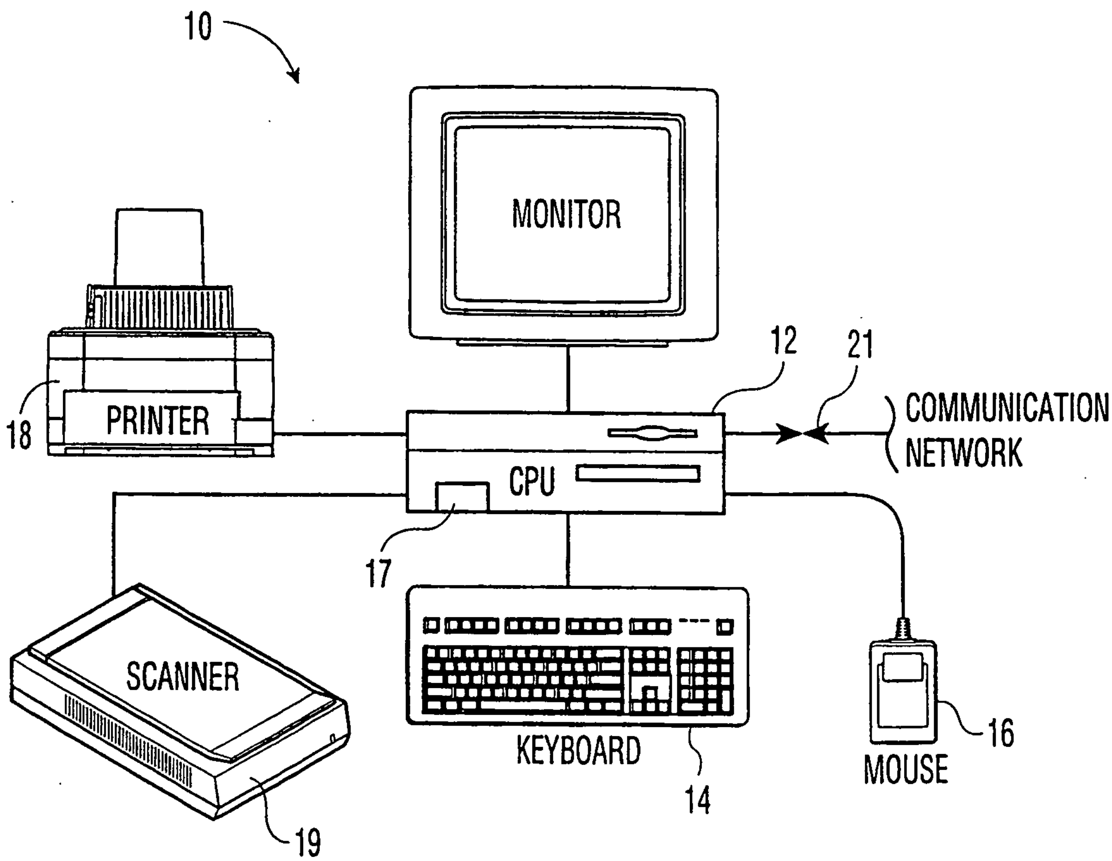
10
MONITOR
PRINTER
18
12
21
COMMUNICATION
NETWORK
CPU
17
SCANNER
19
KEYBOARD
14
MOUSE
16

FIG. 1

2/12

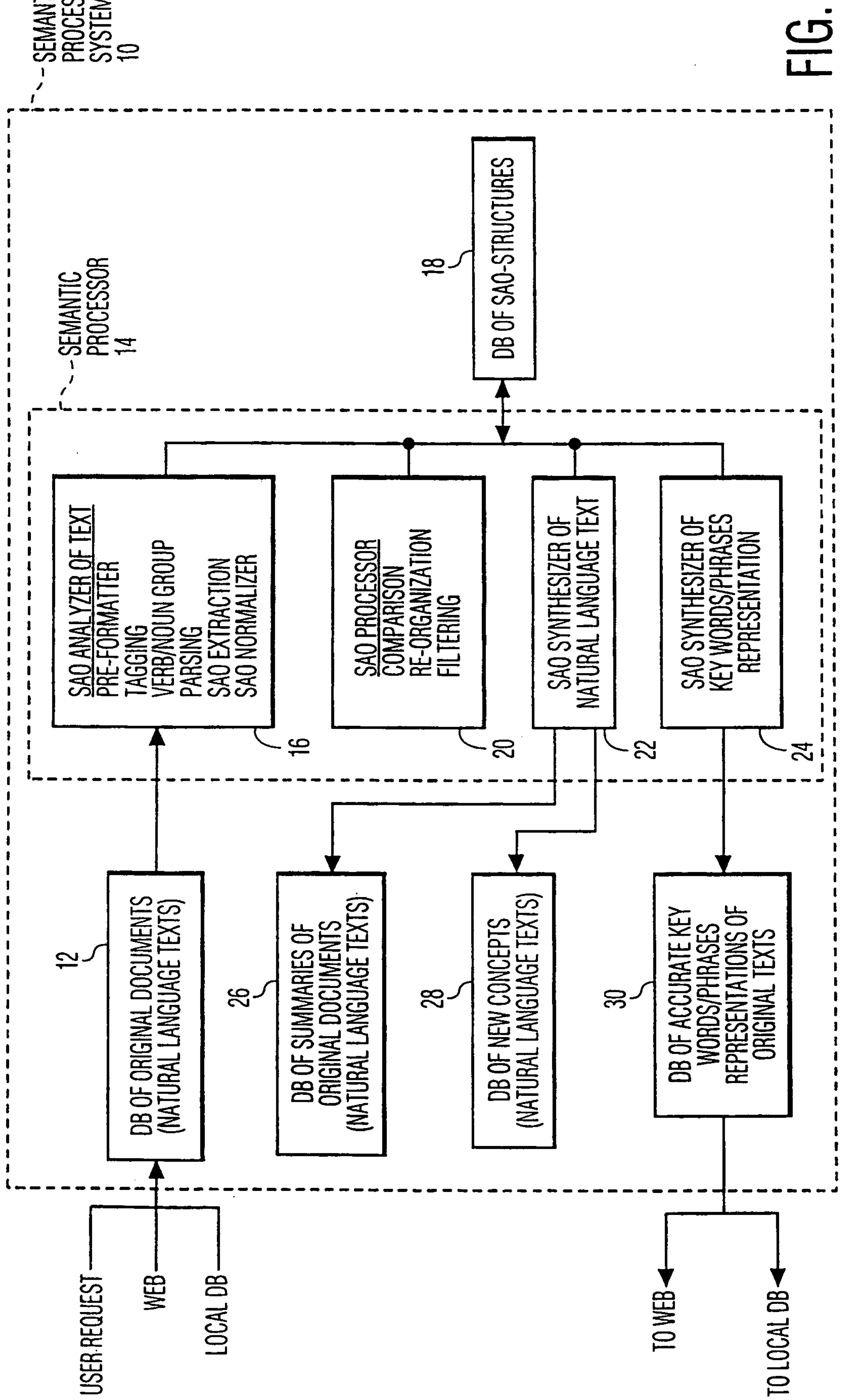
SEMANTIC PROCESSOR SYSTEM 10
SEMANTIC PROCESSOR 14
18
DB OF SAO-STRUCTURES
SAO ANALYZER OF TEXT
PRE-FORMATTER
TAGGING
VERB/NOUN GROUP
PARSING
SAO EXTRACTION
SAO NORMALIZER
16
SAO PROCESSOR
COMPARISON
RE-ORGANIZATION
FILTERING
20
SAO SYNTHESIZER OF NATURAL LANGUAGE TEXT
22
SAO SYNTHESIZER OF KEY WORDS/PHRASES REPRESENTATION
24
12
DB OF ORIGINAL DOCUMENTS (NATURAL LANGUAGE TEXTS)
26
DB OF SUMMARIES OF ORIGINAL DOCUMENTS (NATURAL LANGUAGE TEXTS)
28
DB OF NEW CONCEPTS (NATURAL LANGUAGE TEXTS)
30
DB OF ACCURATE KEY WORDS/PHRASES REPRESENTATIONS OF ORIGINAL TEXTS
USER REQUEST
WEB
LOCAL DB
TO WEB
TO LOCAL DB

FIG. 2

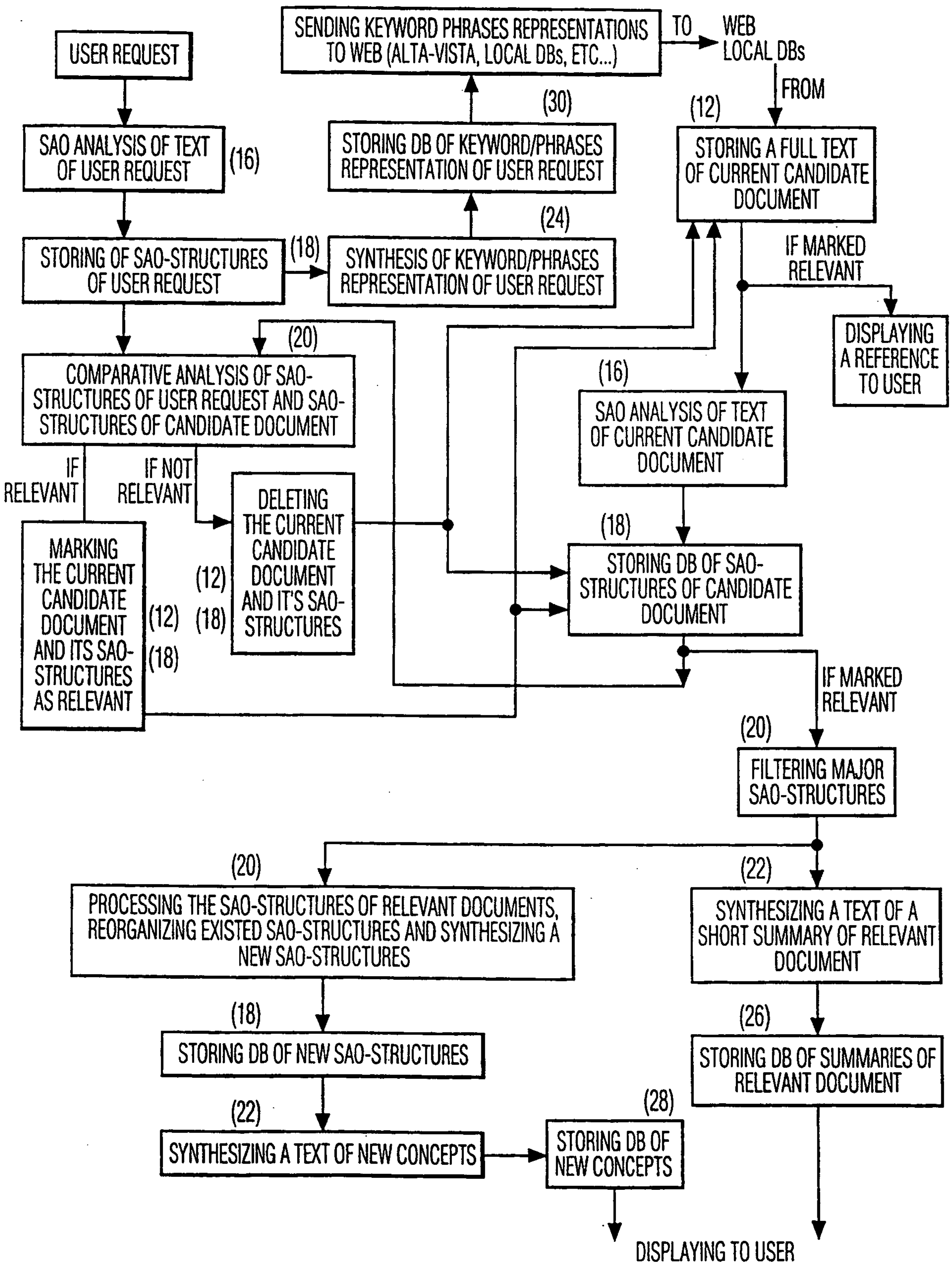
USER REQUEST
SAO ANALYSIS OF TEXT OF USER REQUEST
(16)
STORING OF SAO-STRUCTURES OF USER REQUEST
(18)
SYNTHESIS OF KEYWORD/PHRASES REPRESENTATION OF USER REQUEST
(24)
STORING DB OF KEYWORD/PHRASES REPRESENTATION OF USER REQUEST
(30)
SENDING KEYWORD PHRASES REPRESENTATIONS TO WEB (ALTA-VISTA, LOCAL DBs, ETC...)
TO
WEB
LOCAL DBs
FROM
(12)
STORING A FULL TEXT OF CURRENT CANDIDATE DOCUMENT
IF MARKED RELEVANT
DISPLAYING A REFERENCE TO USER
(20)
COMPARATIVE ANALYSIS OF SAO-STRUCTURES OF USER REQUEST AND SAO-STRUCTURES OF CANDIDATE DOCUMENT
IF RELEVANT
IF NOT RELEVANT
MARKING THE CURRENT CANDIDATE DOCUMENT AND ITS SAO-STRUCTURES AS RELEVANT
(12)
(18)
DELETING THE CURRENT CANDIDATE DOCUMENT AND IT'S SAO-STRUCTURES
(12)
(18)
(16)
SAO ANALYSIS OF TEXT OF CURRENT CANDIDATE DOCUMENT
(18)
STORING DB OF SAO-STRUCTURES OF CANDIDATE DOCUMENT
IF MARKED RELEVANT
(20)
FILTERING MAJOR SAO-STRUCTURES
(20)
PROCESSING THE SAO-STRUCTURES OF RELEVANT DOCUMENTS, REORGANIZING EXISTED SAO-STRUCTURES AND SYNTHESIZING A NEW SAO-STRUCTURES
(18)
STORING DB OF NEW SAO-STRUCTURES
(22)
SYNTHESIZING A TEXT OF NEW CONCEPTS
(28)
STORING DB OF NEW CONCEPTS
(22)
SYNTHESIZING A TEXT OF A SHORT SUMMARY OF RELEVANT DOCUMENT
(26)
STORING DB OF SUMMARIES OF RELEVANT DOCUMENT
DISPLAYING TO USER

FIG. 3

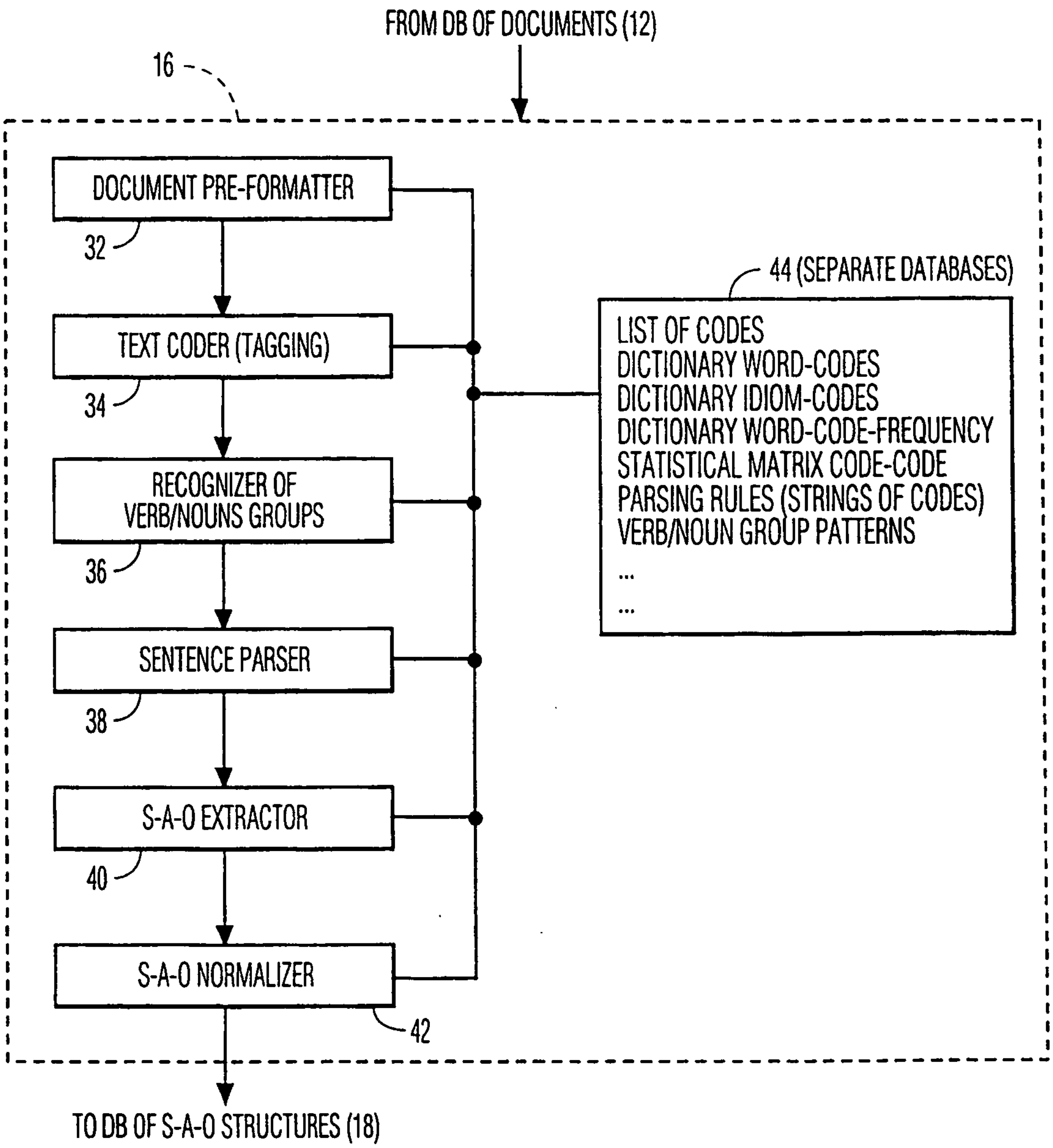
FROM DB OF DOCUMENTS (12)
16
DOCUMENT PRE-FORMATTER
32
TEXT CODER (TAGGING)
34
RECOGNIZER OF VERB/NOUNS GROUPS
36
SENTENCE PARSER
38
S-A-O EXTRACTOR
40
S-A-O NORMALIZER
42
44 (SEPARATE DATABASES)
LIST OF CODES
DICTIONARY WORD-CODES
DICTIONARY IDIOM-CODES
DICTIONARY WORD-CODE-FREQUENCY
STATISTICAL MATRIX CODE-CODE
PARSING RULES (STRINGS OF CODES)
VERB/NOUN GROUP PATTERNS
...
...
TO DB OF S-A-O STRUCTURES (18)

FIG. 4

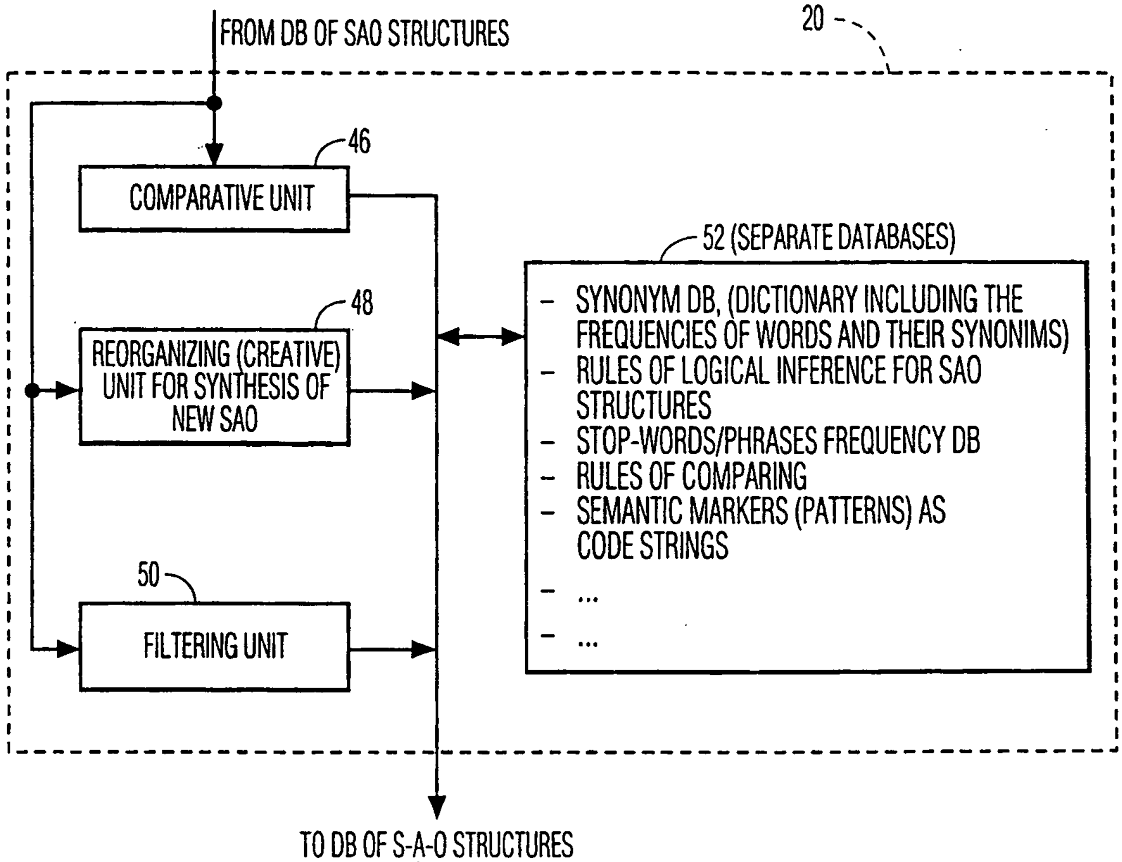
FROM DB OF SAO STRUCTURES
20
46
COMPARATIVE UNIT
52 (SEPARATE DATABASES)
48
REORGANIZING (CREATIVE) UNIT FOR SYNTHESIS OF NEW SAO
- SYNONYM DB, (DICTIONARY INCLUDING THE FREQUENCIES OF WORDS AND THEIR SYNONIMS)
- RULES OF LOGICAL INFERENCE FOR SAO STRUCTURES
- STOP-WORDS/PHRASES FREQUENCY DB
- RULES OF COMPARING
- SEMANTIC MARKERS (PATTERNS) AS CODE STRINGS
- ...
- ...
50
FILTERING UNIT
TO DB OF S-A-O STRUCTURES

FIG. 5

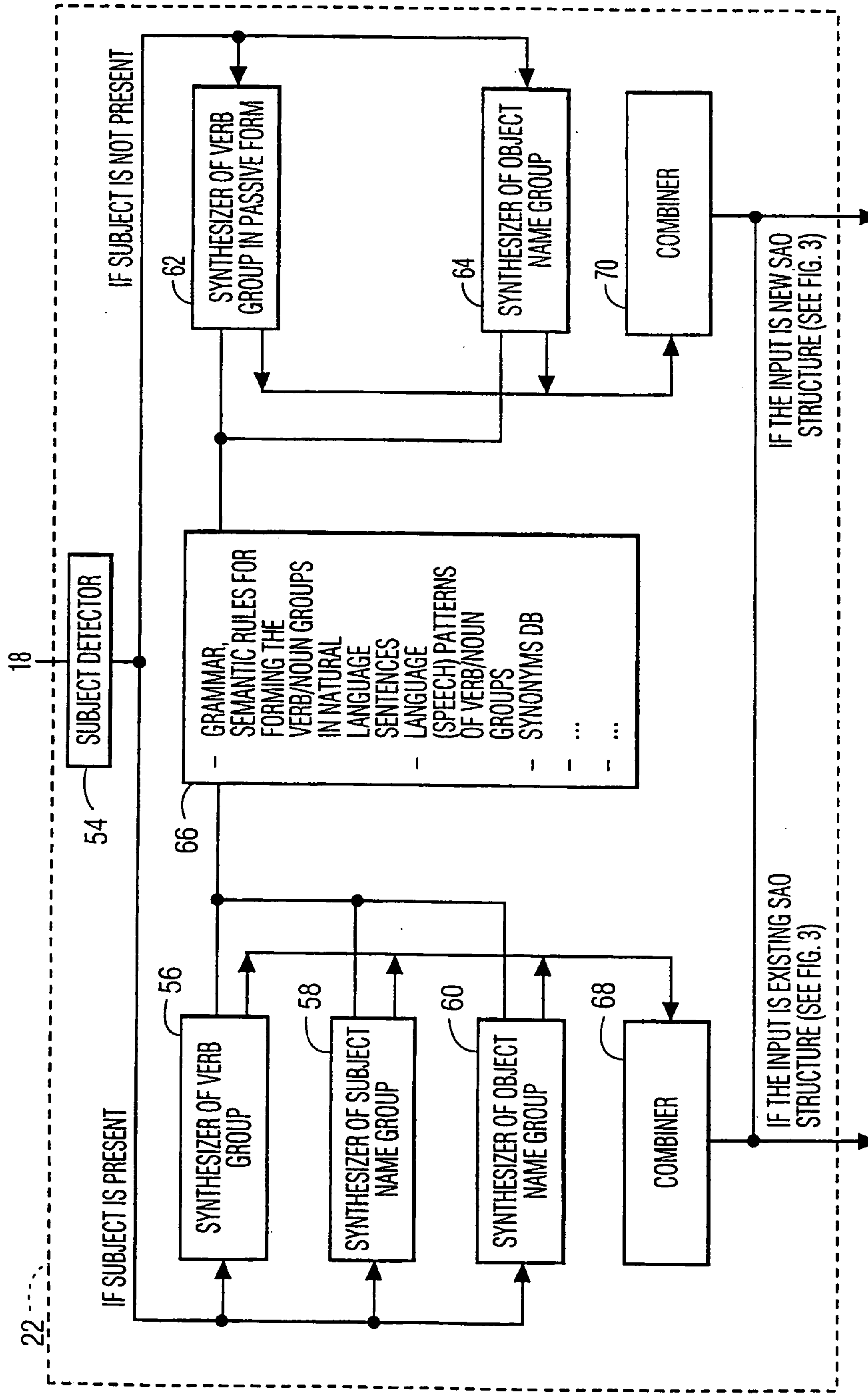
18
SUBJECT DETECTOR
54
IF SUBJECT IS NOT PRESENT
62
SYNTHESIZER OF VERB GROUP IN PASSIVE FORM
64
SYNTHESIZER OF OBJECT NAME GROUP
70
COMBINER
(28)
IF THE INPUT IS NEW SAO STRUCTURE (SEE FIG. 3)
66
– GRAMMAR, SEMANTIC RULES FOR FORMING THE VERB/NOUN GROUPS IN NATURAL LANGUAGE SENTENCES
– LANGUAGE (SPEECH) PATTERNS OF VERB/NOUN GROUPS
– SYNONYMS DB
– ...
– ...
IF SUBJECT IS PRESENT
56
SYNTHESIZER OF VERB GROUP
58
SYNTHESIZER OF SUBJECT NAME GROUP
60
SYNTHESIZER OF OBJECT NAME GROUP
68
COMBINER
IF THE INPUT IS EXISTING SAO STRUCTURE (SEE FIG. 3)
(26)
22

FIG. 6

SOURCE SENTENCE

The present invention shields a noise of an external magnetic field with the slider and improves a recording performance because the slider is isolated magnetically.

FIG. 7

TAGGED SENTENCE

The_ATI present_JJ invention_NN shields_VBZ a_AT noise_NN of_IN an_AT external_JJ magnetic_JJ field_NN with_IN the_ATI slider_NN and_CC improves_VBZ a_AT recording_NN performance_NN because_CS the_ATI slider_NN is_BEZ isolated_VBN magnetically.

FIG. 8

VERB GROUPS ALLOCATION

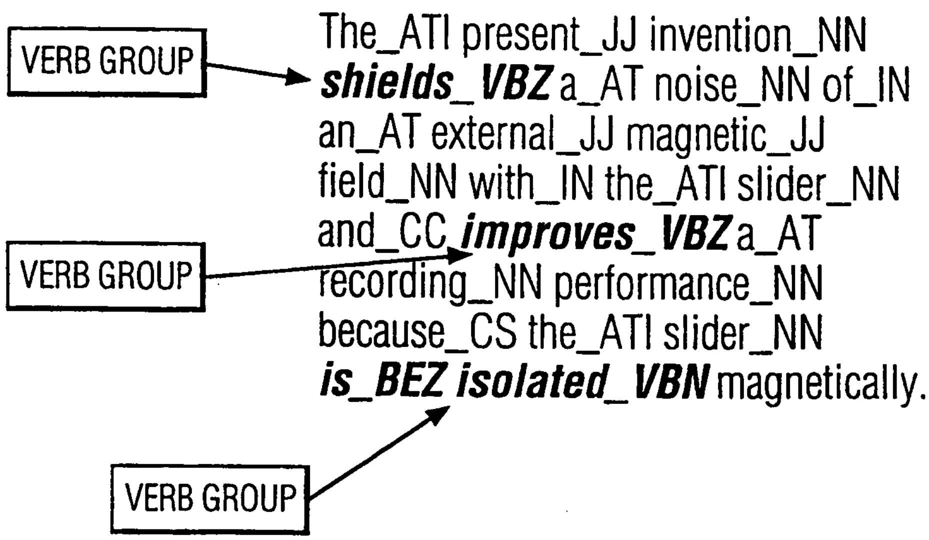

FIG. 9

PCT/US99/19699

NOUN GROUPS ALLOCATION

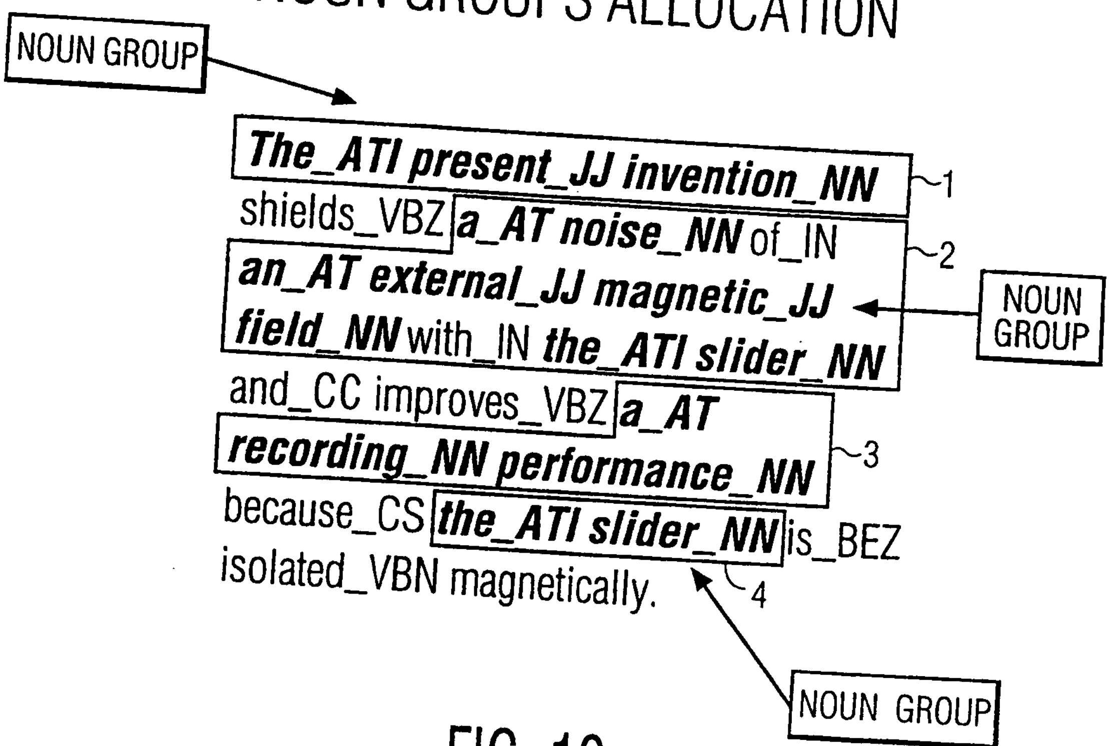

FIG. 10

SAO EXTRACTION

SUBJECT	ACTION	OBJECT
THE PRESENT INVENTION	SHIELDS	A NOISE OF EXTERNAL MAGNETIC FIELD
THE PRESENT INVENTION	IMPROVES	A RECORDING PERFORMANCE
	IS ISOLATED	THE SLIDER

FIG. 12

SAO EXTRACTION (NORMALIZED)

SUBJECT	ACTION	OBJECT
PRESENT INVENTION	SHIELD	NOISE OF EXTERNAL MAGNETIC FIELD
PRESENT INVENTION	IMPROVE	RECORDING PERFORMANCE
	ISOLATE	SLIDER

FIG. 13

INTERNATIONAL SEARCH REPORT

International application No.
PCT/US99/19699

A. CLASSIFICATION OF SUBJECT MATTER
IPC(6) :G06F 17/28, 21, 30
US CL :704/9
According to International Patent Classification (IPC) or to both national classification and IPC

B. FIELDS SEARCHED

Minimum documentation searched (classification system followed by classification symbols)
U.S. : 704/9, 1, 10; 707/2, 3, 4, 5, 6, 104, 530, 531, 532

Documentation searched other than minimum documentation to the extent that such documents are included in the fields searched

Electronic data base consulted during the international search (name of data base and, where practicable, search terms used)
Please See Extra Sheet.

C. DOCUMENTS CONSIDERED TO BE RELEVANT

Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
A, P	US 5,878,385 A (BRALICH, et al) 02 March 1999 abstract, fig. 1, col. 6, lines 13-60; col. 13, line 5 to col. 17, line 55	1-21
A, P	US 5,844,798 A (URAMOTO) 01 December 1998 abstract, col. 11, line 1 to col. 12, line 67; col. 16, line 1 to col. 19, line 11	1-21
A	US 5,802,504 A (SUDA et al) 01 September 1998 abstract, col. 1, line 16 to col. 2, line 33	1-21
X	US 5,799,268 A (BOGURAEV) 25 August 1998 abstract, figs. 1-5 & 7-14; col. 1, line 53 to col. 6, line 16; col. 6, line 65 to col. 12, line 27; col. 12, line 30 to col. 13, line 22; col. 39, line 40 to col. 42, line 51; col. 57, line 10 to col. 65, line 67	1-21

[X] Further documents are listed in the continuation of Box C. [ ] See patent family annex.

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Date of the actual completion of the international search 28 OCTOBER 1999	Date of mailing of the international search report 17 NOV 1999
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INTERNATIONAL SEARCH REPORT

International application No.
PCT/US99/19699

B. FIELDS SEARCHED
Electronic data bases consulted (Name of data base and where practicable terms used):

EAST

search terms: semantic processing, natural language, subject, action/verb, object, SAO/SVO, synonym, request, extract

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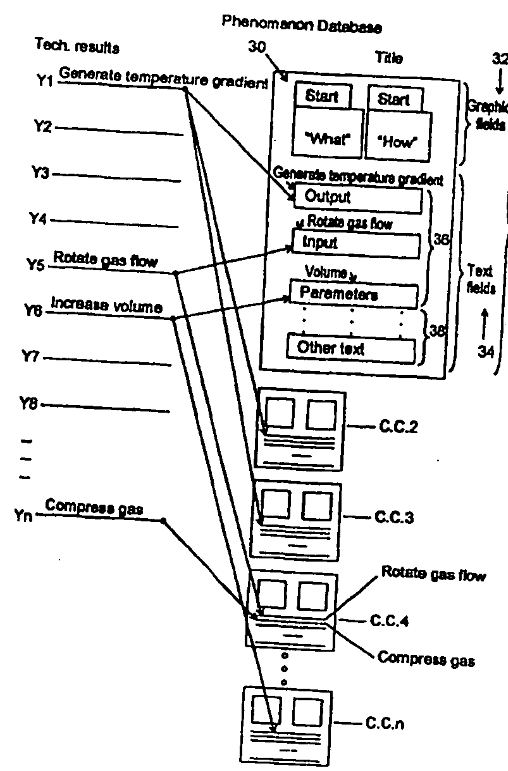
(54) Title: COMPUTER BASED SYSTEM FOR DISPLAYING IN FULL MOTION LINKED CONCEPT COMPONENTS FOR PRODUCING SELECTED TECHNICAL RESULTS

(57) Abstract

A digital computer-based concept engineering system (CES) that includes a data base of concept components (30) (Y = f(x)) of which includes input (36), output (36) and control parameters (38), text descriptions (34), and full motion graphics (32) of a device or system that functions as $y = f(x)$ of a device. The CES provides three problem solving modes, including direct linking automatically to produce full-motion graphical representations (32) of $x_2 \Rightarrow f_2 \Rightarrow x_1 \Rightarrow f_1 \Rightarrow y$ and a control-linking mode to produce full-motion graphical representations of concept components that control parameters (38) of $y = f(x, a, b, c)$. The CES forms new and useful combinations of concept components into a unique concept engineering system, which produces new or improved technical results. Full-motion graphics (32) of unique combinations of concept components stimulate the user to generate creative ideas for technical problem solving design.



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TITLE: COMPUTER BASED SYSTEM FOR DISPLAYING IN FULL MOTION LINKED CONCEPT COMPONENTS FOR PRODUCING SELECTED TECHNICAL RESULTS

BACKGROUND:

The present invention relates generally to engineering problem solving and design information processing systems and more particularly to computer based systems for aiding engineers, scientists and the like to have a greater understanding of the products, processes, or machines they wish to improve and the technical problems related thereto that they wish to solve.

Great advancements have been made in the fields commonly known as computer aided design (CAD) and computer aided engineering (CAE). These computer based systems enable the designer to create detailed images and print-outs of the product, process or machine he/she is designing or improving. With CAD, the designer can try many new designs or modifications of subsystems and components quickly and view the modified products immediately on the monitor or print-out. The CAD system also generates virtual 3-D images of the product or

machine, enables in-space rotation of the product image and zoom through the product image interior.

Although CAD systems are a great designer tool for trying design changes quickly, they do not otherwise aid the designer in the evaluation and solving of technical engineering problems or conceiving new products or processes that provide new functional performance or the same functional performance with completely different engineering approaches. Accordingly, there has arisen a relatively new area of computer based engineering tools known as concept engineering computer based systems. These systems serve to increase the designers inventive and creative abilities in solving engineering and scientific operational or functional problems and, in the course of such problem solving, induce the designer to invent new structural and functional concepts applicable to his/her design goals.

One such concept engineering computer based system is the TECHOPTIMIZER™ software sold by Invention Machine Corporation of Boston, Massachusetts and described in pending Patent Application SN 08/822,314, filed November 12, 1996 that comprises a knowledge and logic based information processing system for generating conceptual engineering system definition and problem analyses. This system automates the process of originating the statement of the most important technical problems for elimination of components or harmful inter-actions between components of the object system being analyzed or redesigned.

Another concept engineering computer based system is the Invention Machine™ LAB™ Software sold by Invention Machine Corporation of Boston, Massachusetts, that comprises a knowledge and logic based system that generates concepts and recommendations for solving engineering problems at the conceptual level. Various inventive rules or procedures are included and certain ones are selected and presented to the user for consideration in solving the user's current session problem. This system applies to all fields of physical science and aids the engineer by solving engineering contradictions to reduce the tendency of user applied engineering trade-offs. The system includes a large data base of physical, geometric, and chemical effects used in the past to solve other engineering problems. Selected ones of the effects are presented to the user for consideration by the user as potential solutions to his/her current problem session. The system also includes a technology evolution and prediction capability that aids the user in understanding the dynamics of his/her product evolution and the logical next or future generation of the product or its function. This stimulates the user to think forward and extrapolate the dynamics of the technology life cycle and originate the next generation of technology.

Although the above mentioned computer based concept engineering systems have experienced much acceptance by the technical community, there is still a need for alternate methods of concept engineering that enable the user to rapidly and comprehensively understand the nature of the technical result he/she wishes to achieve and the structure and function of various engineering devices

that, if linked together, can produce the desired technical result.

There is also a need in concept engineering and design systems for the computer based system to rapidly, effectively and visually present to the user the capability of searching for the precise technical result he/she desires and displaying to the user in brief but comprehensive form an engineering system or device, what the physical effect is, and how the device can produce the desired technical result. The problem here is generating for the user information in such a way that enables the user to obtain and understand substantially immediately, e.g. within one or two minutes, the technical problem the user must address to achieve the desired technical result.

In addition, there is a need to present to the user/designer for consideration various subsystems that either control or affect the parametric environment for the engineering device under consideration or that can function as a series of input-output stages for the system representation that produces the desired technical result.

SUMMARY OF EXEMPLARY EMBODIMENT OF INVENTION:

It has been found by the present inventors that the designer's creative capabilities and ability to generate quickly many technical ideas is greatly enhanced when the technical designer can view full motion graphics of the physical effect system that produces the desired technical result as well as the system that can comprise one or more inputs to the engineering system under consideration.

According to one aspect and objective of the system according to the present invention, the concept engineering system includes a data base of many individual systems each of which is associated with an engineering system or device for responding to a predefined input action or cause and producing and output or technical result in accordance with some physical laws or rules herein referred to as a physical effects. Unlike conventional systems, the system according the present invention includes a data base that not only includes word descriptions of the physical effects, but also includes macro graphic of what the physical effect is and a second micro graphic of how the physical effect device produces the technical result. In addition, both the macro and micro graphics can show full motion for 5 to 10 seconds at the option of and under the control of the user. Further, the physical effect data base according to the present invention includes mathematical equations that indicate the parameters, and certain ones of these parameters are selected by the present system to be control parameters for a control linking mode more fully described below.

Another object and aspect of the present invention is to provide a new and improved computer based system which meets the needs of the user as described above and presents a quick and powerful way for the user to define his/her technical problem and present suggestions of engineering systems that can conceptually solve the problems or improve the technical result desired. It is first necessary to understand that concept engineering systems or engineering concept components can be represented and analyzed as an input/output device. This

representation can be expressed mathematically as Y=f(x), or an output result (y) is a function or physical effect (f) of an input action or cause (x). An example of this for a photocell device is: the current (y) from a photocell is a function (f) of the input light intensity (x) absorbed by the photocell. The function (f) comprises the mathematical equations physically inherent in the photocell device.

This can be represented by:

$x \rightarrow \boxed{f} \rightarrow y$

where x = light intensity

f = the mathematical function of the photocell

y = current

Often the designer may have the problem wherein the system does have a light source available as an input to the engineering device (photocell). Accordingly, the designer needs to decide what other engineering device to add to the system that can generate the input (light) to the photocell based on what actions or inputs are available to the designer. This can be represented as:

$y = f(x_1)$

$x_1 = f(x_2)$

Where x_3 is some other cause or input

is some other physical effect device

x_1 is light

f is Photocell

y is Current

A further extension of the required stages where three devices are arranged such that the output of one serves as the input of the next can be represented as:

$$X_3 \rightarrow \boxed{f_3} \rightarrow x_2 \rightarrow \boxed{f_2} \rightarrow x_1 \rightarrow \boxed{f_1} \rightarrow y$$

Accordingly, one aspect and objective of the information processing system according to one embodiment of the present invention is a computer based system capable of analyzing engineering systems and automatically searching for and displaying the combination of two or more physical effects which the computer based system automatically arranges to serially interact with one another and which will improve or produce the desired technical result Y. This process routine is termed direct linking, as the system searches for outputs that can serve as inputs to successive stages of functional devices.

An alternate method of analyzing engineering systems in an exemplary embodiment of the present invention includes representing the device that embodies the physical effect and modifying the technical result by adjusting the control parameters of the device.

This can be represented as:

$Y = f(x, a, b, c)$

Where Y = Technical result

X = input action

a,b,c = separate parameters of the mathematical equation f such as temperature, pressure, frequency, etc.

Another aspect and objective of the present invention is to provide an

information processing system that displays the engineering object and its physical effect that produces the desired technical result, searches for and displays combinations of other physical effect devices that can produce outputs that control specific control parameters of the engineering object.

In one example of a system according to the principles of the present invention, computer based system includes at least one database:

(1) a Technical Results (Y) Database,

(2A) a word description Physical Effects (f) Database with word, equation and table description of each physical effect, each entry includes a number of fields, further described below, the includes words include the input field, output or technical result field, synonym field, mathematical equation field, etc.

(2B) a Graphics Physical Effects (f) (still and full motion) Database with a macro (what) and micro (what presentation level on each physical effect, and

(3) a set of physical rules, synonym expressions, and links between stored database entries.

The computer based system includes two main stages, a problem statement stage and an effect based solution stage, although the user can move between these two stages at will. In the problem statement stage, the user can select one of three ways to enter a problem statement. The user can: 1. Select the Technical Result statement in which case the Technical Result (TR) or outfiled data or contents is displayed and the user simply selects the TR he/she wants to obtain, the problem becomes how to obtain the selected TR, or 2. Select a Find box which presents the

user with the option of entering one or more key words or combination of words, the problem becomes how to obtain the effect(s) of a system that includes a physical effect that includes the key words entered by the user, or 3. Select a define option which enables the user to select from the data base his or her own X, Y concept component and control parameters from prompted lists. The problem then is how to improve or control the described user concept component.

Once the problem statement is entered, the user can then access and operate the system in three alternate problem-solving modes: a direct linking mode, a control linking mode, or a browse mode.

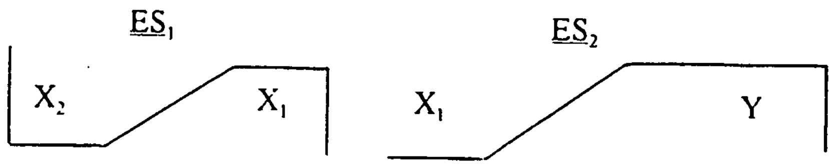
When the browse mode is accessed for the TR problem statement procedures, the system displays in one portion of the monitor all the Y entries or Technical Results fields contents entries in some order, such as alphabetical order. The user can scroll through these entries and click (select) the one that is likely to or may represent the output of his/her design task. Selecting a particular entry may yield one, two or more sublevels or entries affording the user a greater degree of selection control. The selection of the lowest level technical result in that chain brings up a display under the selected TR the engineering devices or concept component from the data base that have the selected TR as an output. The user can point the curser (EG, arrow) to any displayed concept component and the computer based system will automatically show a short, e.g. 5-second, still macro graphic of that physical effect device. If the user clicks on that or any of the listed concept component, then there will be displayed on the monitor a word description

and associated Macro and Micro Graphic of the selected component that has an output (Y), i.e. the same output as the selected technical result. The word description includes an explanation of the effect, tables, formulas (stating control parameters), structural and operating conditions, outside references and other information as desired. The graphic, initially a single frame, includes a start button which when selected starts a short, e.g., 5 - 10 second, full motion macro operation of the engineering system/device displayed. It also includes a detail button, which when selected, displays a second full motion graphics showing how the physical effect produces the Technical Result. This micro level graphic also includes a 5-10 second motion start button. In this way, the user's understanding is rapidly and greatly raised through motion graphics, detailed formula, and word descriptions as to what the physical effect is and how his selected Technical Result is achieved. This raised level of understanding leads to the user rapidly generating new ideas for solving or achieving Engineering system design improvements.

The user can alternately select or move to a direct linking mode in which case the Technical Result or output field entries are displayed as described above for the browse mode. Again the user selects a particular technical result of interest. The system then automatically displays a list of various engineering systems with the output (Y) which is the same as the technical result (Y) selected by the user. In addition, it displays the various inputs to each engineering system/device that produced the specific Y result <u>and</u> it will also link to and list other engineering systems/devices that have outputs (X_n) that can serve as inputs

to the engineering system/device that produced Y.

The rule for and display on the monitor can be represented as:



or:

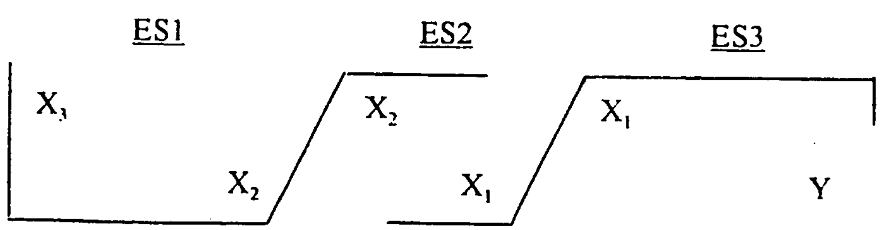
ES1 ES2

$X_2 \rightarrow \boxed{f} \rightarrow X_1 \rightarrow \boxed{f} \rightarrow Y$

Where Y is the technical result selected by the user as mentioned above. Note the computer system automatically searches for and selects the input engineering system to serve as input to ES_2 that produces Y.

In addition, macro graphic representations of ES_1 and ES_2 are displayed with full motion capability as described above.

In the event a third, intermediary, engineering system is required with mating input/output so that the last device will properly generate Y, then the computer system automatically searches for and insert it. This action is represented as:



or:

$$\underset{\underline{ES1}}{X3 \rightarrow \boxed{f} \rightarrow} \quad \underset{\underline{ES2}}{X2 \rightarrow \boxed{f} \rightarrow} \quad \underset{\underline{ES3}}{X1 \rightarrow \boxed{f} \rightarrow Y}$$

Therefore, the computer system according to an exemplary embodiment of the invention implements a direct linking routine to present the user with new combinations of two or three interactive engineering systems that can produce the designer's desired technical result and simultaneously display motion graphics of the physical effects involved.

In the control mode, the user again is presented with the Technical Result entries in one portion of the monitor and he/she selects a particular Technical Result (Y) of interest. In this case the word description and macro graphic of an engineering device with Y as its output are displayed on the monitor. However, the controlling parameters (a,b,c in the above mentioned example) are also listed in association with the graphic and the user can alternately select one or more of these parameters in sequence. Clicking on one parameter causes the computer system to display one, or, in sequence, a set of word descriptions and graphic representations of engineering systems that control, affect, or generate that specific parameter. All graphic displays have full motion capability as described above. Therefore, the user is presented with a unique combination of engineering devices for controlling specific parameters for optimizing or improving the output or technical result Y of the engineering system under analysis.

Other and further objects, benefits, and advantages afforded by the

exemplary embodiments of the present invention will become apparent with the following detailed description when taken in view of the appended drawings in which:

Figure 1 is conceptual overview of exemplary embodiment of the CES according to the principles of the present invention.

Figure 2 is a graphical representation of the fields of each concept component of the CES of Figure 1.

Figure 3 is a flow diagram of the define routine.

Figure 4 is a flow diagram of the find routine.

Figure 5 is an overview of the session start routine.

Figure 6 is a conceptual and pictorial representation of the concept components CC1...CCN and search routines.

Figure 7A-D is a flow chart of the direct linking routine starting from direct access.

Figure 8A-C is a flow hart of the direct linking routine starting from the define problem statement.

Figure 9A-C is a flow chart of the direct linking routine starting from the find problem statement.

Figure 10 is a flow chart of the browse routine starting from direct access.

Figure 11A-B is a flow chart of the control linking routine starting from the find problem statement.

Figure 12A-B is a flow chart of the control linking routine starting from the

define problem statement.

Figure 13A-C is a flow chart of the control linking mode starting from the direct access problem statement.

Figure 14 is a display on session start.

Figure 15 is a display when function if Figure 14 is selected.

Figure 16 is a display when objects of Figure 14 is selected.

Figure 17 is a display when alphabetically Figure 14 is selected.

Figure 18 is a display of a concept component including brief graphic and macro and micro full motion graphics.

Figure 19 is a display when Figure 18 and direct linking is selected.

Figure 20 is a display when the second linked combination is selected.

Figure 21 is a display when control linking is selected in Figure 14.

Figure 22 is a display of the start of the find routine.

Figure 23 is a display of the Figure 22 when the key word right arrow is selected.

Figure 24 is a display of Figure 23 when the absorption of light by aerosol is selected.

Figure 25 is a display of the start of the define routine.

Figure 26 is a display of Figure 25 when the effect name is completed and one parameter is selected.

Figure 27 is a display of Figure 25 when the direct linking mode is selected.

Figure 28 is a display of Figure 25 when control linking mode is selected

and the listed parameter is selected.

With reference to Figures 1-13, an exemplary embodiment of the technical concept engineering system according to principles of the present invention includes a computer based information processing system, a conceptual block diagrammed overview of which is shown in Figure 1. The concept engineering system (CES) 10 includes two main stages; the problem statement stage 12 and the problem solving stage 14. A user can input data and control methods of problem statement and modes of problem solving sequentially, or move between stages 12 and 14 at any time to modify previously entered data, or enter new data at will. The computer based CES 10 includes a database 16 in which each entry is a unique engineering concept component that includes a set of fields, described below, that represent a physical or other effect from any domain of science and technology. For example, each engineering concept component entry can include 15 fields, or more, such as those shown in Figure 2 and Figure 6. Two main categories of fields include graphical fields and text fields. Graphical fields include a macro graphical field with full motion and a micro graphical field with full motion. The text fields include formal type text fields that support linking routines, described below, and informal type text fields that convey information and support word or formula searching but do not support linking. Formal text fields include a component output (Y) field, an input field (x), and control parameter fields (a,b,c) and equivalents of any data entered, such as "x-ray" and "radiation in the x frequency band." The informal fields include names or titles of the engineering component,

including synonyms or equivalent names or titles, word explanations pertaining to the concept component entry, mathematical formulas, materials, captions for graphical representations, references, conditions, advantages, and other entries desirable and useful to the user.

With reference to Figure 6, the upper right shows the main elements of a concept component display server 30 with graphic fields 32 and text fields 34, format text fields 36 and informal text fields 38. Data for each concept component (CC1-CCN) field set (Figure 2) would be entered and stored in association with the specific CC identity, e.g., a unique 5-digit word. The CES includes the ability to search specific fields in all CC database entries. For example, if the user in direct access designates generate temperature gradient as the desired technical result, then the CES search routine will compare this technical result with the output fields of CC1, CC2...CCN. The identity of those CC entries having "generate temperature gradient" or the equivalent technical result will be stored to form a list of CCs having the desired output.

The CES can form direct links between CCs by, for example, search the CC input fields for "rotate gas flow" and storing the identities in a list and searching the CC output fields for "rotate gas flow" and storing the resulting identities in a list 2. The CES then forms and stores the list of direct links search as the link between CC4 and CC1 of Figure 6.

The CES also performs key word or combination of word searches of all text fields and stores the identities of those CCs in which the words are found and

highlights those words when the specific CC is displayed.

With reference to Figure 1, at session start up, the user has the option of initiating problem statement through a define routine 18 or a find routine 20, or the user can access the database directly through a direct access routine 22 that displays database concept component entries in one of three ways (see Figure 5) selectable by the user: alphabetically by technical result (Y), alphabetically by the object of the technical result(Y), and alphabetically by the names or titles of the component entries. Selecting any single component entry will display the full concept component as described below and enable the user to use it as a problem statement, e.g., a desired technical result.

The define routine 18 is selected when the user wants to define his/her own custom engineering concept component in order to improve it. When the define button is selected the CES displays a dialog box that prompts the user to enter data in the name filed, to select an input (x) and an output (Y), and one or more control parameters (a,b,c,). Once this is done, the user may save the user concept component data (user concept component) and close the define dialog box to complete defining the problem statement. Of course, the user can return to the define routine 18 at any time to modify the component, add data as desired, or to define another user concept component. When user concept component definition is completed, the CES enables certain selection capabilities, i.e., control linking and direct linking as described below.

Alternatively, the user may select the find routine 20 to start the problem as

a key word or word combination. When the find button is selected the CES displays a dialog box that prompts the user to enter key words or combinations of key words for supporting a search process that displays all concept components that include those words or combinations of words entered by the user, in any respective field (see Figure 4). The results of the search can be displayed as a list of component names or titles, a list of technical results (Y), inputs (x), or some other field listing. If desired, the user can elect to perform a search within their previous search results. When a search within a search (s w/i s) is selected, only the stored results of the immediately previous search are searched. Alternatively, when the user does not perform a search within a previous search, then the entire database of text fields are searched. Once the key words are entered, the find routine 20 shown in Figure 4 begins. The database is accessed and key word(s) search performed. Results are stored and displayed as selected by the user. Once the user is satisfied with the search, the user can select one or more displayed search results and each entire identified concept component is displayed. The user can save this selection, and the selected and saved concept component becomes part of the problem statement for subsequent problem solving modes described below.

The exemplary three modes of problem solving are now described. It is preferred that one of the problem solving modes, e.g., direct linking, control linking, or browse serve as a default mode so that upon session start up, the CES is in a known problem solving mode. In one embodiment of the present invention,

direct linking is selected as the default mode of problem solving. The user can select an alternate mode by selecting (clicking) on a mode button 24, 26, 28, in the tool bar.

Referring to Figure 1,2, 7A-D, direct linking problem solving mode first accesses the entire database of concept component entries and searches the output fields thereof. It is necessary for the operation of direct linking mode for the CES to know the desired technical result (Y) selected by the user either via the direct access method of problem statement mentioned above. Each concept component entry that includes the selected technical result (Y) in its output field is stored in a list 1 of possible concept components that may form part of an engineering concept system that solves the problem statement, how to produce Y.

Next, as shown in Figure 7B, the direct linking routine calls each entry from the stored list 1 and examines each input field thereof. The entire database is again accessed, entry by entry and the output fields of each entry examined to determine a match between the input field data of each list 1 entry (element of link) and the output field of each database entry. For those that match, the identity of the corresponding concept component is stored in list 2 (another element of link). As seen in Figure 7C, the process is repeated for examining the inputs of each entry f list 2, searching for an output match throughout the database entries and storing the results in a third list, list 3 (another element of link), of concept components. The routine continues in Figure 7D to reconfigure and combine the results of the three lists into linked outputs and output for various components that

satisfy the statement

$$X_2 \rightarrow \boxed{f_2} \rightarrow X_1 \rightarrow \boxed{f_1} \rightarrow Y$$

or

$$X_3 \rightarrow \boxed{f_3} \rightarrow X_2 \rightarrow \boxed{f_2} \rightarrow X_1 \rightarrow \boxed{f_1} \rightarrow Y$$

as described above.

In addition, the results are displayed for the user in a list in graphical form as desired and enables the user to select any combination of interest. The CES then simultaneously displays the graphic representation (macro) corresponding to each linked concept component and, as described above, enables full motion upon actuation of a start button for any or all graphic representations. In this way, direct linking presents the user with a number of linked concept components that conceptually interact with one another to form a conceptual engineering system that solves the stated problem and provides the desired technical result (Y). It should be appreciated that since the direct linking routine selects concept components based on input and output fields and without regard to a particular scientific or engineering discipline, the user is presented with a range of potentially viable solutions both within and beyond their particular area of technical expertise, thereby stimulating innovation. In essence, the CES stimulates the user's creative capabilities by importing many technical ideas, theories, applications, and knowledge in a very short amount of time.

If the user develops the problem statement with the define routine, then the direct linking problem solving mode routine can be implemented as shown in

Figure 8A-D. Note that the search and match sequences can be the same as those described with respect to Figures 7A-D. However, the CES searched the output fields of the called up database entries and identified matches with the input (x) field data selected by the user (see Figure 3). The concept components that include a match are stored in a list 1. The search routine is repeated to store list 2 (Figure 8B). The direct linking routine then links and organizes the lists of C2, C1 and user concept components such as:

$$
\begin{array}{ccccccccccc}
 & \underline{CC2} & & & \underline{CC1} & & & & \underline{CCuser} & & \\
X_3' \rightarrow & \boxed{f_3} & \rightarrow & X_2' \rightarrow & \boxed{f_2} & \rightarrow & X_1 & \rightarrow & \boxed{f_{cc}} & \rightarrow & Y \\
 & & & X_2' \rightarrow & \boxed{f_2'} & \rightarrow & X_1 & \rightarrow & \boxed{f_{cc}} & \rightarrow & Y \\
X_3'' \rightarrow & \boxed{f_3'} & \rightarrow & X_2'' \rightarrow & \boxed{f_2''} & \rightarrow & X_1 & \rightarrow & \boxed{f_{cc}} & \rightarrow & Y
\end{array}
$$

The problem solving direct linking mode routine, starting from the find problem statement is shown in Figures (A-C). Each database entry is called in turn and the data from its output field is examined and compared with the input field of the concept component found by the find routine described above. The identity of matched components is stored as list 1. In Figure 9B, each list 1 entry is examined and its input data extracted. Subsequently, the output fields of each database entry is obtained and compared with the input fields of list 1 concept components. Those entries that match have their identity stored in list 2. In Figure 9C, lists 1 and 2 are applied to a subroutine that forms a list of direct links for the problem statement found components, list 1 and list 2 components. The CES displays these linked combinations possible system solutions, such as:

$$X_3 \rightarrow \boxed{f_3} \rightarrow X_2 \rightarrow \boxed{f_2} \rightarrow X_1 \rightarrow \boxed{f_1} \rightarrow Y$$

$$X_2' \rightarrow \boxed{f_2'} \rightarrow X_1' \rightarrow \boxed{f_1'} \rightarrow Y$$

Where f_1 is the result of the "find" routine.

The control linking mode from the find method of problem statement can be seen in Figures 11A-B. Each concept component is called and its output field searched for a match with each control parameter of the system found concept component, that is the result of the find routine. Matching concept component identities are store as list 1 for each control parameter. Thereafter, the system forms a list of control links for the found concept component by linking the found concept component parameters with those in the stored list 1. The list of control links is then stored. Next, the system enables the user to select (click on) any displayed link to pull up the entire concept component and its user viewable fields. If desired, the first control link in the list could come up as a default.

The control linking problem solving mode routine starting from the define problem statement method is shown in Figures 12A-B. The routine is similar to that of Figures 11A-B, except that the output field data is compared for match with the control parameters entered by the user (see Figure 3). The system displays a list of control links and enables the user to select any requested control link (see Figure 21).

The Browse mode, started from the direct access method of problem statement is shown in Figure 10. The browse subroutine accesses and examines each output field of each concept component. If the output field data matches the

desired technical result identified in the direct access problem statement, then the identity of the concept component will be stored in a list of components each of which has an output equivalent to the technical result identified by the user. The identities of the matched components are stored in a list and displayed under or in association with the problem statement technical result. The user selects (clicks on) any of the listed concept components and the full concept component with all user visible fields will be displayed as stated above.

The control linking mode starting from the direct access problem statement is shown in Figures 13A-C. The output field data of each concept component database entry is examined and compared with the desired technical result selected by the user during the direct access routine. The identity of those components that match are stored in list 1. In Figure 13B, the control parameters of each entry of list 1 is compared with the control parameters of each database entry and those concept component identities that have matching control parameters are stored as list 2. In Figure 13C, the system forms a list of control links by linking Lists 1 and 2 for the desired technical result. The list of control links is stored. The display initially includes the concept component having the selected technical result and the list of its control parameters. The user selects a control parameter and the first entry of the linked concept component for controlling that parameter is displayed. The user can select other links for display. Each display includes a graphics (full motion if start button pressed) and word description of the desired technical result and a graphics (full motion) and a word description of the selected and linked

concept component that can control the specific parameter of the technical result component under analysis. In this way the user is presented with a number of concept components that can modify or improve the technical result (Y) of the component selected by the user during the direct access routine.

Figures 14-28 depict one example of the graphical user interface (GUI) of a engineering concept component system according to one illustrative embodiment of the present invention. Figure 14 illustrates a top level screen as seen by a user of the CES after system start-up. The GUI includes a number of user selectable buttons in a menu bar. These buttons include a Direct button that activates direct linking mode, a Control button, that activates control linking mode, and a Browse button that activates browse mode. The buttons also include a Define button that initiates the define routine, a Find button that initiates the find routine, as well as other buttons whose function should be apparent to those skilled in the art. See Figure 1.

As shown in Figure 14, when the user's pointing device is positioned over any one of the Functions, Objects, Alphabetically, or User Customized folders, a corresponding alphabetically arranged list of Functions, Objects, database entry titles or names, or user custom effects, are respectively displayed on a right hand portion of the display.

Figures 15, 16, and 17, illustrate a lower level screen that is presented to the user when one of the Functions, Objects, or Alphabetically folders is pointed to and selected by a user. As can be seen by comparing Figures 15 and 16, the

displayed technical results in both the Functions folder and the Objects folder include the same items, but expressed in two alternative ways, i.e., "functions" are expressed as a verb then an object of the verb, whereas "objects" are expressed as an object (for instance a material, a field, a process, a parameter) and a verb that acts in some way upon the object. This technique aids the user in searching for and finding the precise technical result of interest. Figure 17 shows the alphabetical listing of names or titles of all concept components in the database.

Figures 18-28 depict various screens that would be seen by a user in attempting to solve a particular problem, for example, filtering sunlight. As shown in Figure 18, the user has selected the direct access mode of problem statement definition in Browse mode, as the user is perhaps uncertain as to how to best express their problem. After examining the function sub-folder "absorb radiation" from the Absorb Field, Forces, Energy folder, the user determines that the concept component "Absorption of light by aerosol" looks intriguing, As depicted in Figure 18, when the user first positions the pointing device, e.g., mouse pointer, over a particular concept component, a graphical representation of that concept component is briefly displayed for about 3 to 5 seconds, and then disappears. Accordingly, the user specifically selects Absorption of light by aerosol. As can be seen in Figure 18, after selection by the user, graphical representations of the selected effect, and a detailed written explanation of that selected effect are displayed in the right hand portion of the screen. The graphical representations of the selected effect include both a macro graphical representation that shows "what"

the selected technical effect does, as well as a micro graphical representation that shows "how" the selected technical effect achieves a particular technical result. Although not visible in Figure 18, each of the graphical representations is a motion-based graphical representation that can be viewed statically and dynamically, with motion-based viewing being repeatable as desired. This motion graphic capability helps to convey a technological appreciation of a given selected effect in a manner which is rarely possible with text based description alone. In addition, although not depicted in Figure 18, further information, such as mathematical formula describing the effect, advantages of the effect, technical references and other informal field data further describing the effect are available to the user by scrolling down in a conventional manner.

If the user wants to consider various conceptual components that could produce the aerosol/light effect, then the user would select the direct linking mode. In this mode, the CES would investigate possible systems that could produce this effect, alone, or in combination with other systems.

Figure 19 depicts a screen in which the user, after selecting the direct linking mode and absorb radiation from the Absorb Field, Forces, Energy folder, has specifically selected Absorption of light by aerosol. In such a situation, the user would select direct linking to investigate possible systems that could use this effect, alone, or in combination with other systems. The user ca select direct linking by selecting the Direct button in the tool bar, for example.

Upon selection, and as depicted in Figure 19, motion based macro graphical

representations of the first directly linked effect is visually displayed on the left side of the link representation. In written terms, this graphical representation informs the user that an increase in the concentration of aerosol droplets increases light absorption by the aerosol, and that cavitation of a liquid can produce an aerosol. Figure 19 also shows that there is more than one way to produce an aerosol, for example, by vapor condensation, and also shows that more than two effects can be directly linked by the CES to present potential solutions to the user. When the user selects a particular directly linked solution, that solution is graphically displayed (i.e., is brought to the foreground). As shown in Figure 20, the other potential solutions can be viewed graphically by the user (statically or dynamically) by selecting on them to pull them to the foreground one at a time.

If the user wants to improve the performance of the selected absorption by light effect, then the user selects the control link mode.

Figure 21 depicts a screen in which the user, after selecting the control mode and absorb radiation from the Absorb Field, Forces, Energy folder. Accordingly, after selecting Absorption of light by aerosol, the user selects control linking (either before or after selection of the effect), for example, by selecting the Control button in the tool bar. As noted earlier, control linking is especially useful for improving a system or result, or eliminating harmful or wasteful side effects or by-products of a system by modulating characteristics of parameters effecting that system. As shown in Figure 21, the user is informed that there are two ways of increasing light absorption by an aerosol. One of these is by changing the

dimension of the aerosol particles, and the other is by changing the wavelength of radiation of the light input. As in other potential problem solutions, full motion graphical representations of the control linked effects, and an in depth written explanation are displayed to the user.

Figure 22 illustrates a display screen that is presented to the user when the Find mode of problem analysis is selected by the user, for example, by selecting the Find button in the tool bar. The find mode may be used when the user has a vague idea (a broad key word) or a clear idea (a number of specific key words, perhaps as a Boolean combination) of their problem statement. As shown in Figure 22, the user is presented with a Find dialog box in which the user is prompted to input the desired key word or combination of keywords, including logical combinations of key words (for example, AND, OR, NOT). As described previously, the user can search the entire database (e.g., Search in all records) or can refine their previous search results (e.g., Search from previous records found). As depicted in Figure 23, after the user initiates the search routine, for example, by selecting the start button, a list of all entries including the selected key word(s) is displayed in a scrollable list portion of the dialog box. By selecting on a particular entry, the graphical representations (macro and micro) with full motion capability and written description of the selected entry are displayed to the user as shown in Figure 24. Furthermore, as shown in Figure 24, the selected keyword(s) is highlighted in the descriptive text of the displayed entry. In a manner similar to that of browsing technical results via direct access, a graphical representation of that result is briefly

displayed for about 3 to 5 seconds and then disappears when the user positions their pointing device above a particular effect or phenomena

Figure 25 illustrates a display screen that is presented to the user when the Define mode of problem analysis is selected by the user, for example, by selecting the Define button in the tool bar. As noted previously, the Define mode can be used to define a user customized problem statement. As shown in Figure 25, the user is presented with a User Effect Definition dialog box in which the user is prompted to input the desired name or title for the user's effect or user concept component. The user is also prompted to enter an input of the effect, an output of the effect, as well as any control parameters of the effect. The input, output, and parameters designated by the user are used as the input, output, and control parameters used to facilitate direct and control linking of the user's custom effect to other component entries in the database. As should be apparent, the user could only enter an input if direct linking were desired, and could only enter one or more control parameters if control linking were desired. As shown in Figure 26, the user has input the name "My effect" as the name of title of their problem, and has selected inputs and outputs from a drop down list of database component entries that are displayed to the user when accessing those areas of the dialog box. After entering fields, the user can save and close their custom defined problem statement. Furthermore, once define the user can investigate potential solutions to their problem statement by selecting either control linking, or direct linking, for example, using the Control and Direct buttons in the tool bar, respectively.

An illustrative example of a direct linking based solution to the user's custom define problem statement is illustrated in Figure 27, while Figure 28 illustrates a control linking based solution. As shown in Figures 27 and 28, graphical representations corresponding to directly linked and control linked component entries, respectively, are displayed along with text descriptions. By selecting on a particular entry, the graphical presentations (macro and micro) with full motion capability and written description of the respective components are displayed.

It should be understood that an embodiment of the system according to the principles of the present invention includes any suitable known digital computer system with application software storage medium, such as portable disk installed therein, or the application software can be stored or resident on the computer hard drive or networked and resident on a server, as desired. The digital computer system preferably includes a standard input data device (keyboard), printer, monitor for displaying screens of the type mentioned above, and any network connections as desired. It should also be understood that various changes and modifications can be made to the exemplary routines described and illustrated herein and additional features added to the exemplary embodiment and method disclosed herein without departing from the spirit and scope of the present invention.

WE CLAIM:

Claim 1. In a digital information processing system, a method of displaying data associated with one or more concept components (CC), each having the expression y=f(x), the method comprises the steps of:

defining a set of fields for each CC,

designating a first subset of said fields as graphical fields,

designating second subset of said fields that include an input (x) field and an output (y) field,

entering and storing data in association with said first and second subsets of fields,

selecting a CC for display by matching the data in one of the input (x) and output (y) fields with a predetermined technical result (y) or input action or cause (x) and,

displaying the graphic information stored in association with the selected CC.

Claim 2. A method as set forth in Claim 1 wherein the step of displaying includes a still representation of the graphic information and a full motion representation of the graphic information.

Claim 3. In a digital data processing system the method of displaying control parameter linked concept components (CC's) that can improve the output (Y) of a

predetermined CC that can be represented by the expression Y=f(x), the method comprising:

defining a set of fields for each CC,

designating a first subset of said fields as control parameters (a,b,c),

designating a second subset of said fields that include an input (x) field and an output (y) field,

entering and storing data in association with said first and second subsets of fields,

selecting at least one CC for display by matching the information in the output (y) fields with a predetermined CC parameter (a,b,c), and

displaying descriptive information stored in association with the selected CC.

Claim 4. A method as set forth in Claim 3 wherein the descriptive information includes a graphical representation of the selected CC.

Claim 5. A method as set forth in Claim 4 wherein said graphical representation includes full motion and still graphical representations.

Claim 6. In a digital information processing system, the method of displaying direct linked concept components (CC's) that can conceptually serve as input (X) or output (Y) components of a concept engineering system represented by

$X_n \rightarrow f_n \quad X_{n-1} \rightarrow$--- f $\rightarrow$ Y, the method comprising:

defining a set of fields for each CC,

designating a first subset of said fields as graphical fields,

designating a second subset of said fields that include an input (x) field and an output (y) field,

entering and storing data in association with said first and second subsets of fields,

selecting a predetermined CC with input X_1 and output Y,

selecting at least one CC with input X_2 and output X_1 by matching the information in the output field of the selected CC with the information in the input field of the predetermined CC, and

displaying during the same time period the graphical information in the first subset fields of the predetermined and selected CC's.

Claim 7. A method as set forth in Claim 6 wherein the step of displaying includes a user selectively still representation and full motion representation of each graphical information of the respective CC.

Claim 8. A method as set forth in Claim 7 wherein the step of displaying includes displaying a macro graphic and a micro graphic of the respective CC.

Claim 9. A method as set forth in Claim 6 wherein the step of selecting includes

selecting at least one additional CC with input X_3 and output X_2 by matching the information in the output field (X_2) of the additional selected CC with the input (X_2) of the selected CC, and displaying, during the same time period as first mentioned displaying step for the graphical information in the first subset fields of the predetermined CC and the selected CC, the information in the graphical field of the additional selected CC.

Claim 10. A method as set forth in Claim 1 further displaying a list of CC titles and displaying for a brief period a still graphic representation of a CC in response to the computer mouse pointer designating the respective displayed title.

Claim 11. In a digital information processing system, the concept engineering method of displaying data representing one or more concept components (CC) each having the function $Y=f(x)$ and each said CC including input, output, at least one control parameter of a predetermined device or system, said method comprising

a direct linking process for producing and displaying graphical CC combinations representing $X_2 \rightarrow f_2 \rightarrow X_1 \rightarrow f_1 \rightarrow Y$, and

a control-linking process displaying one or more of control parameters (a, b, c) for one or more f_2 and f_1 and producing and subsequently displaying graphical representation of one or more CC's that control predetermined parameters of one or more parameters a, b, c for one or more of f1 and f2, and

wherein useful combinations of CC representations are simultaneously displayed to stimulate the user to generate creative ideas and solutions to conceptual problems.

Claim 12. The method of Claim 11 wherein each said graphical representation includes still and motion graphical representations of a predetermined physical effect.

Claim 13. The method of Claim 12 wherein each said motion graphical representation comprises a macro graphic of what the physical effect is and a micro graphic of how the physical effect is produced.

Claim 14. The method of Claim 11 wherein the method further comprises an initial problem statement process for identifying and storing one of the technical result (Y) desired by the user or the input (X) available to the user.

Claim 15. The method of Claim 14 wherein said combinations of CC representations include at least one of the identified and stored (X) or (Y).

Claim 16. The method of Claim 11 wherein said method further includes

defining a set of fields for each CC,

designating a first subset of said fields as graphical fields,

designating second subset of said fields that include an input (x) field and an output (y) field,

entering and storing data in association with said first and second subsets of fields,

selecting a CC for display by matching the data in one of the input (x) and output (y) fields with a predetermined technical result (y) or input action or cause (x) and,

displaying the graphic information stored in association with the selected CC.

Claim 17. A method according to Claim 11 wherein said method further includes defining a set of fields for each CC,

designating a first subset of said fields as control parameters (a,b,c),

designating a second subset of said fields that include an input (x) field and an output (y) field,

entering and storing data in association with said first and second subsets of fields,

selecting at least one CC for display by matching the information in the output (y) fields with a predetermined CC parameter (a,b,c), and

displaying descriptive information stored in association with the selected CC.

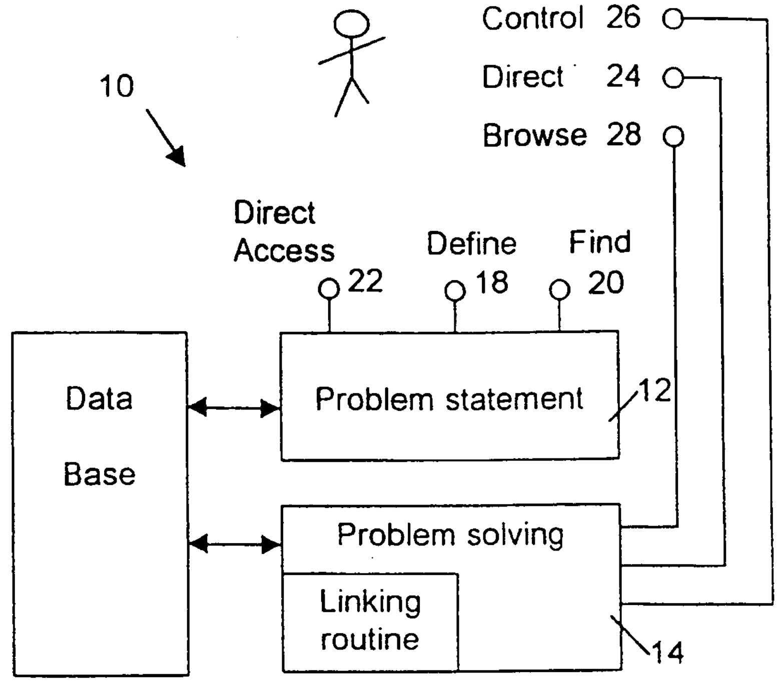

10
Control 26
Direct 24
Browse 28
Direct
Access
22
Define
18
Find
20
Data
Base
Problem statement
12
Problem solving
Linking
routine
14

Fig. 1

Data Base Entry

- Each Concept
  - Set of Fields
    - Graphical
      - macro — full motion
      - micro — full motion
    - Text
      - Formal
        - output (Y)
        - input (X)
        - Control parameter (a, b,
      - Informal
        - name(s)
        - explanation
        - formula
        - materials
        - conditions
        - captions in graphics
        - reference
        - other

Fig. 2

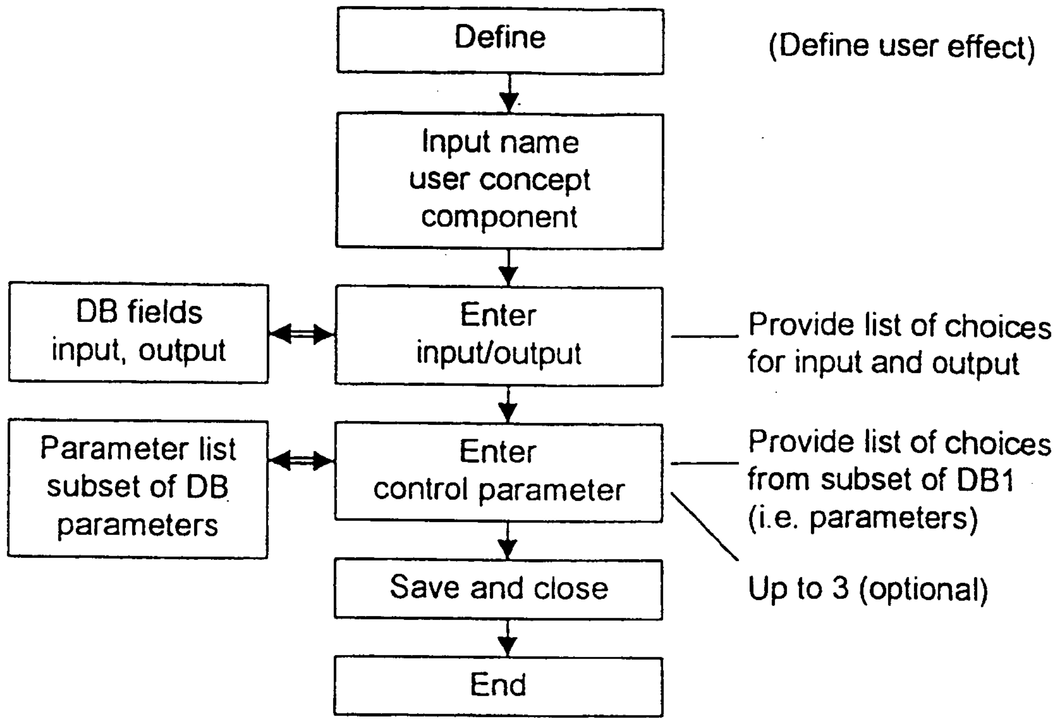

Define
(Define user effect)
Input name
user concept
component
DB fields
input, output
Enter
input/output
Provide list of choices
for input and output
Parameter list
subset of DB
parameters
Enter
control parameter
Provide list of choices
from subset of DB1
(i.e. parameters)
Up to 3 (optional)
Save and close
End

Fig. 3

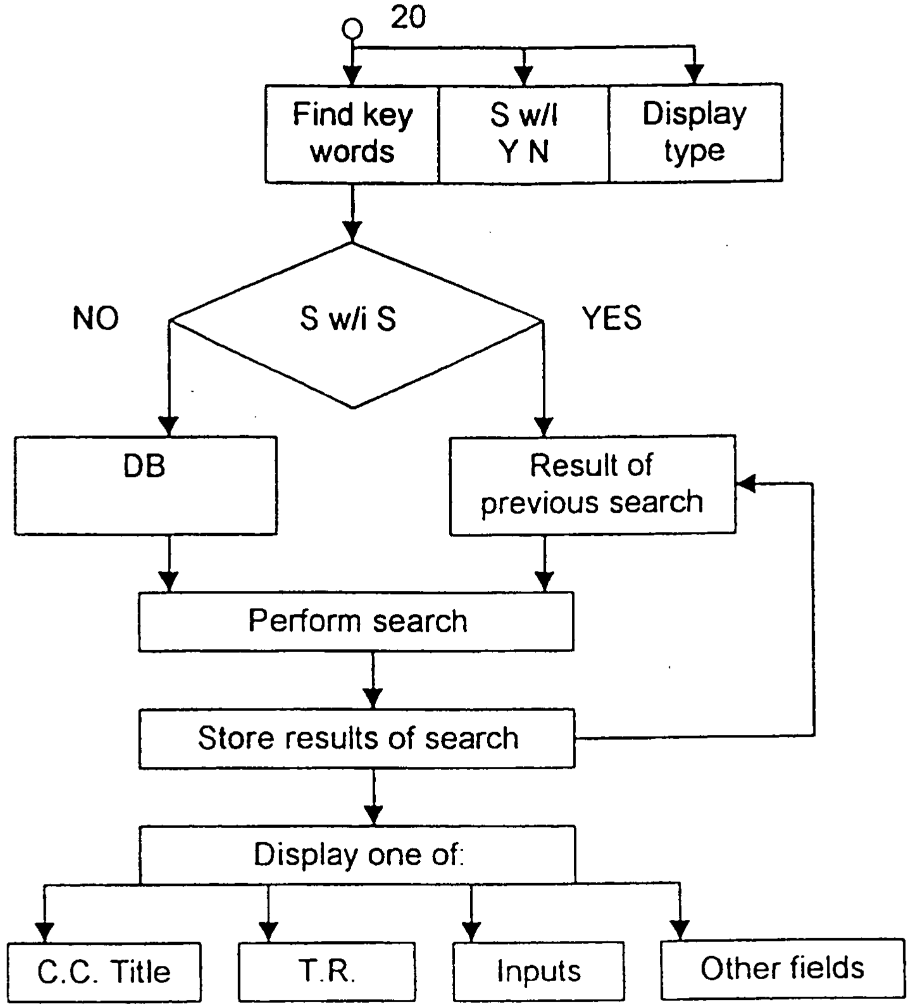

20
Find key words
S w/I Y N
Display type
NO
S w/i S
YES
DB
Result of previous search
Perform search
Store results of search
Display one of:
C.C. Title
T.R.
Inputs
Other fields

Fig. 4

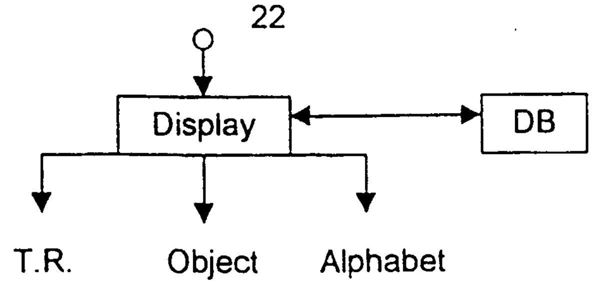
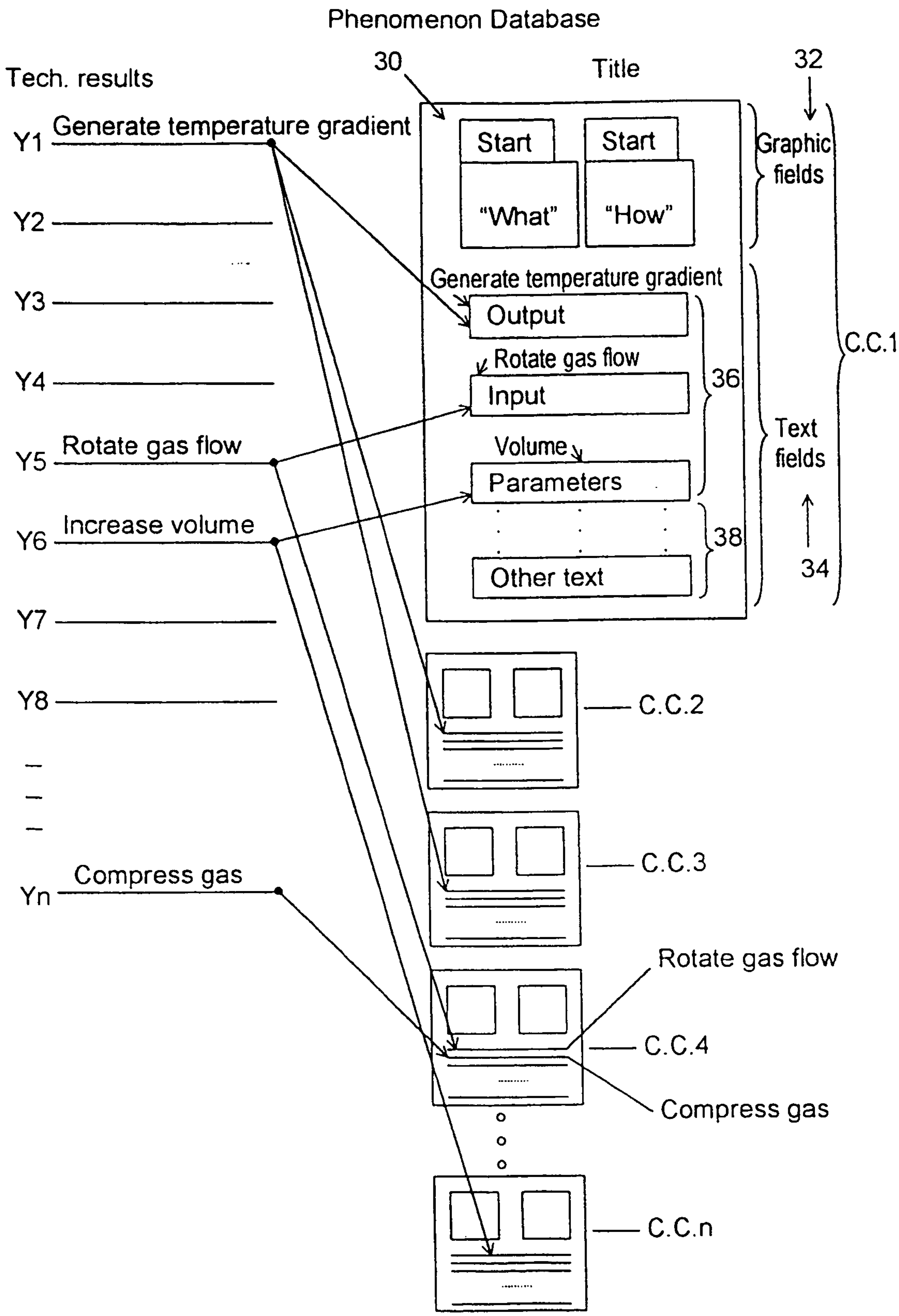


Fig. 5



Phenomenon Database
Tech. results
30
Title
32
Y1
Generate temperature gradient
Y2
Y3
Y4
Y5
Rotate gas flow
Y6
Increase volume
Y7
Y8
Yn
Compress gas
Start
Start
"What"
"How"
Graphic fields
Generate temperature gradient
Output
Rotate gas flow
Input
Volume
Parameters
Other text
36
38
Text fields
34
C.C.1
C.C.2
C.C.3
Rotate gas flow
C.C.4
Compress gas
C.C.n

Fig. 6

Flow chart: Direct linking mode started from direct access to DB

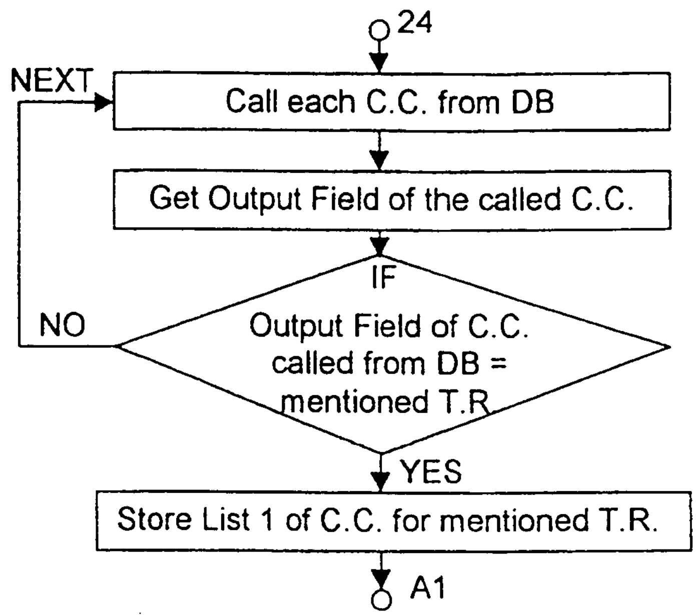


Fig. 7a

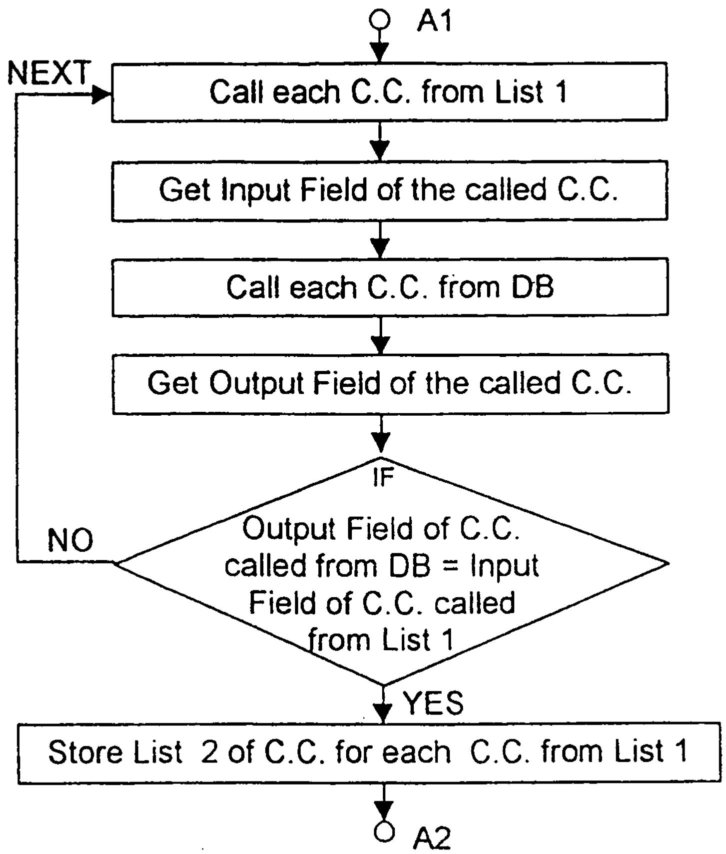

A1
NEXT
Call each C.C. from List 1
Get Input Field of the called C.C.
Call each C.C. from DB
Get Output Field of the called C.C.
IF
Output Field of C.C. called from DB = Input Field of C.C. called from List 1
NO
YES
Store List 2 of C.C. for each C.C. from List 1
A2

Fig. 7b

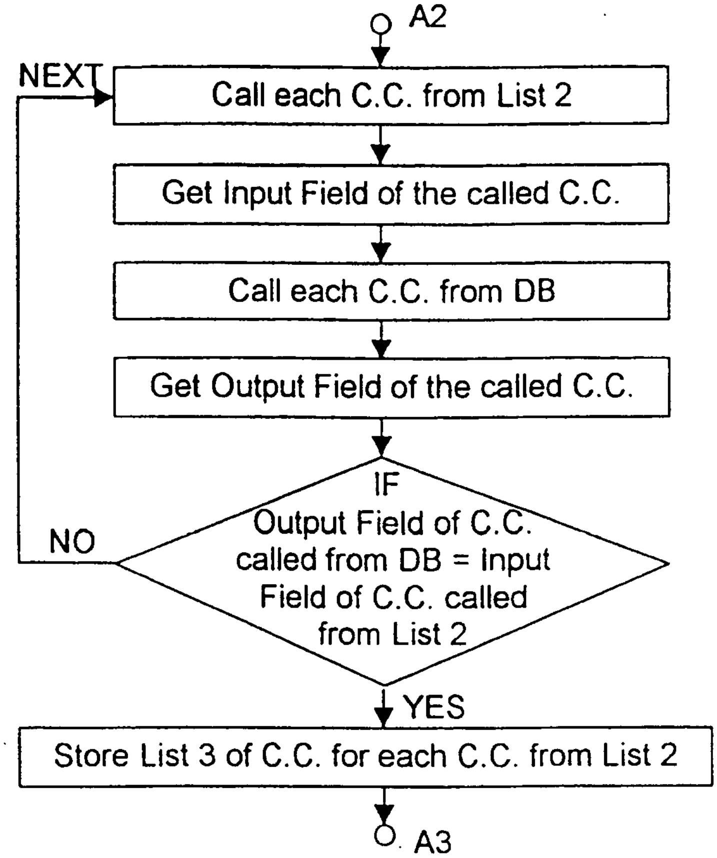

A2
NEXT
Call each C.C. from List 2
Get Input Field of the called C.C.
Call each C.C. from DB
Get Output Field of the called C.C.
IF
Output Field of C.C.
called from DB = Input
Field of C.C. called
from List 2
NO
YES
Store List 3 of C.C. for each C.C. from List 2
A3

Fig. 7c

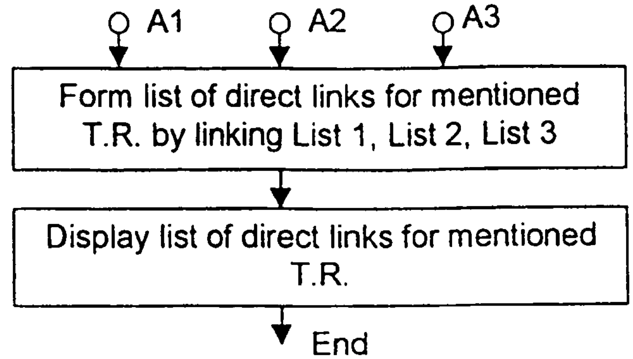

A1
A2
A3
Form list of direct links for mentioned T.R. by linking List 1, List 2, List 3
Display list of direct links for mentioned T.R.
End

Fig. 7d

Flow chart: Direct linking mode started from define user C.C.

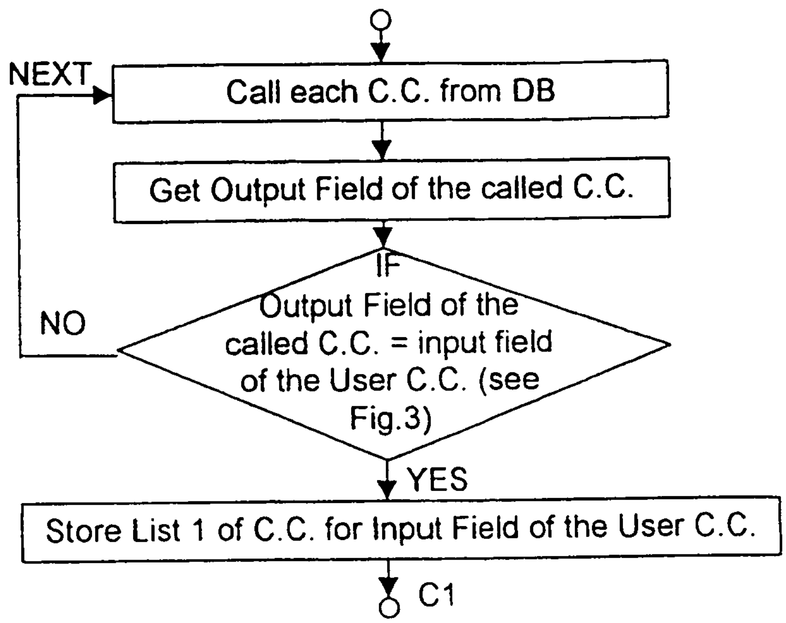


Fig. 8a

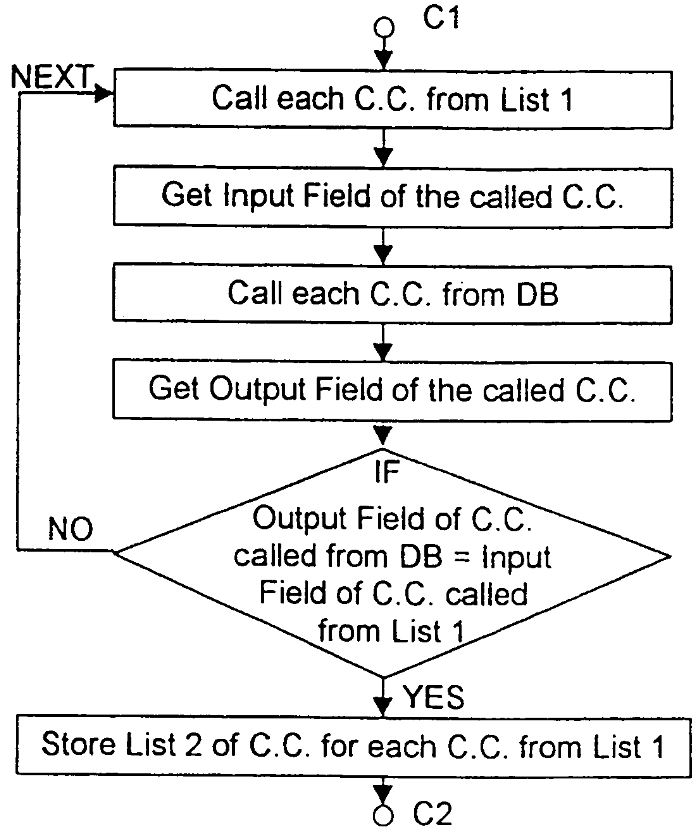

C1
NEXT
Call each C.C. from List 1
Get Input Field of the called C.C.
Call each C.C. from DB
Get Output Field of the called C.C.
IF
Output Field of C.C. called from DB = Input Field of C.C. called from List 1
NO
YES
Store List 2 of C.C. for each C.C. from List 1
C2

Fig. 8b

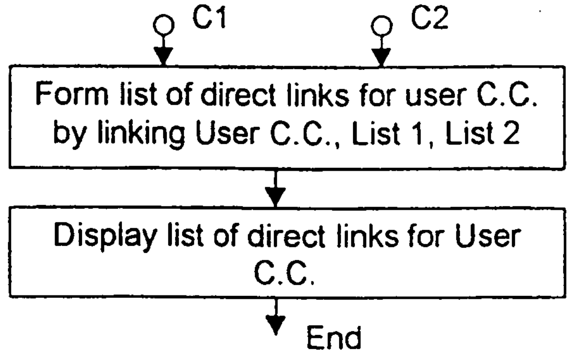

C1
C2
Form list of direct links for user C.C. by linking User C.C., List 1, List 2
Display list of direct links for User C.C.
End

Fig. 8c

Flow chart: Direct linking mode started from Find.

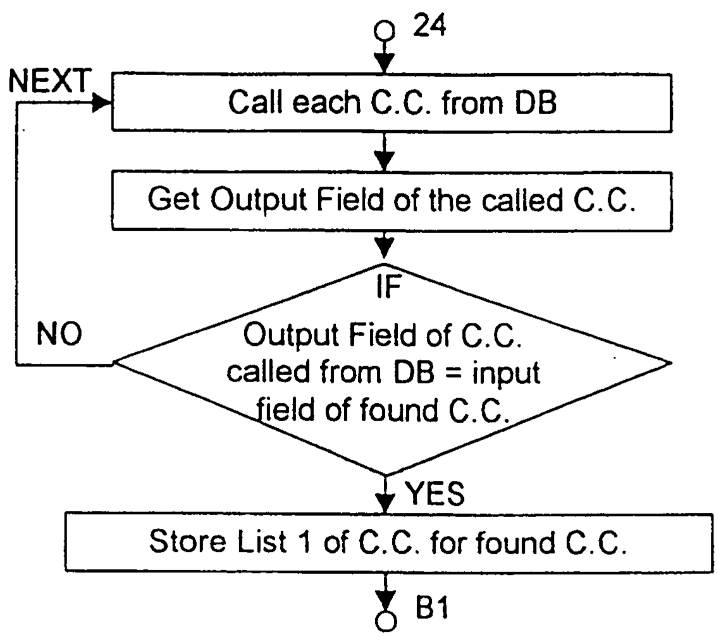


Fig. 9a

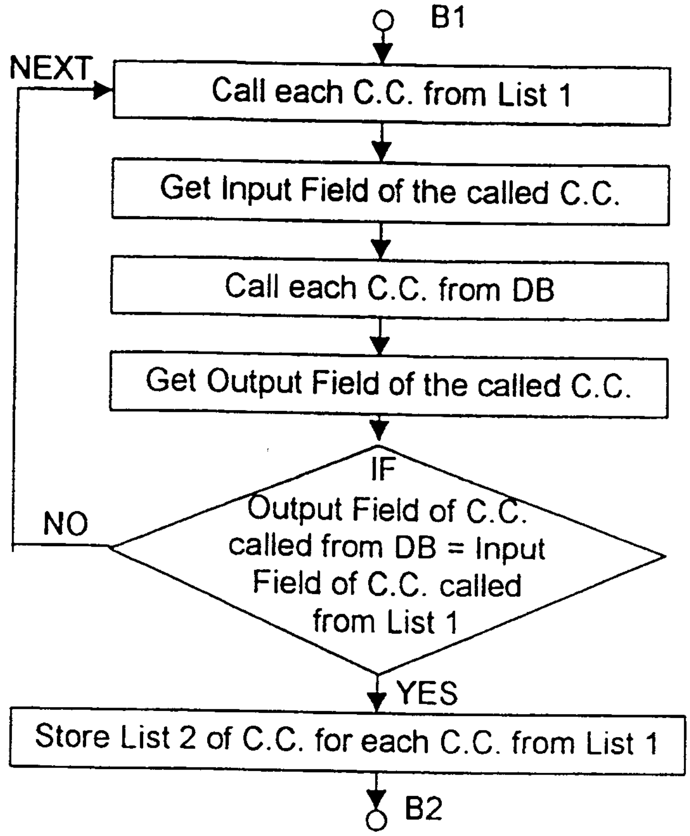

B1
NEXT
Call each C.C. from List 1
Get Input Field of the called C.C.
Call each C.C. from DB
Get Output Field of the called C.C.
NO
IF Output Field of C.C. called from DB = Input Field of C.C. called from List 1
YES
Store List 2 of C.C. for each C.C. from List 1
B2

Fig. 9b

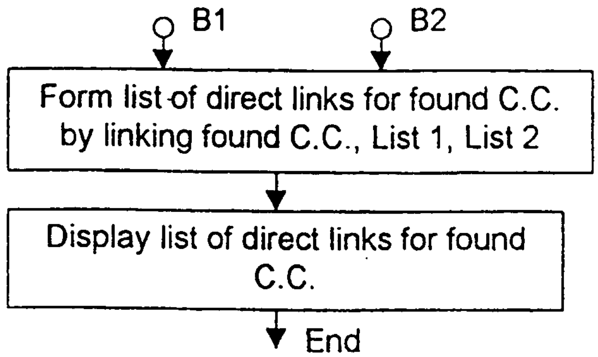

B1
B2
Form list of direct links for found C.C. by linking found C.C., List 1, List 2
Display list of direct links for found C.C.
End

Fig. 9c

Flow chart: Browse mode started from direct access to DB.

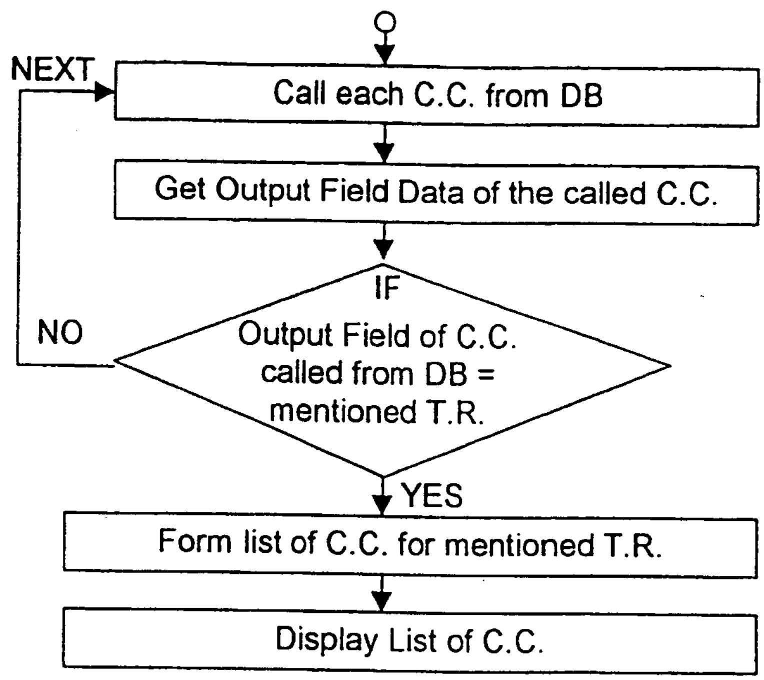


Fig. 10

Flow chart: Problem solution. Control linking mode started from Find.

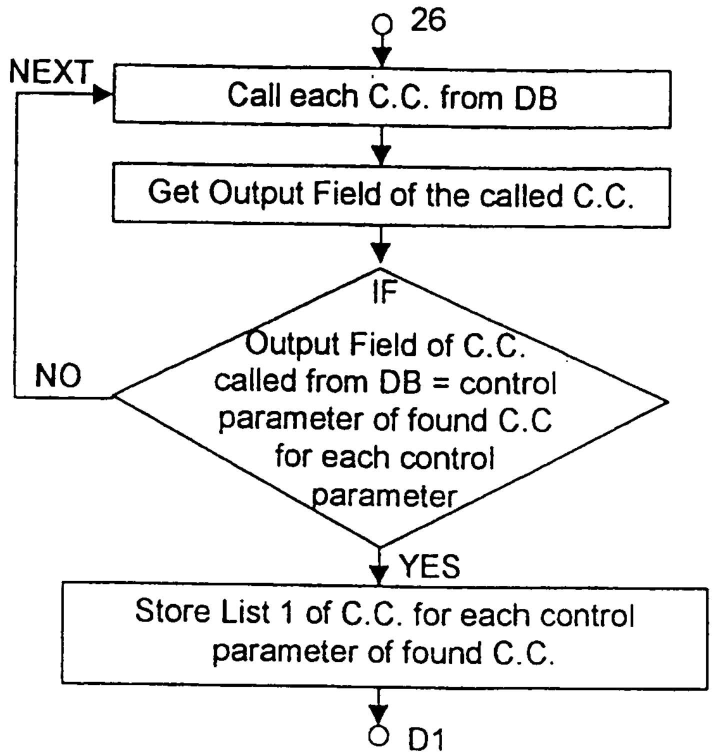


Fig. 11a

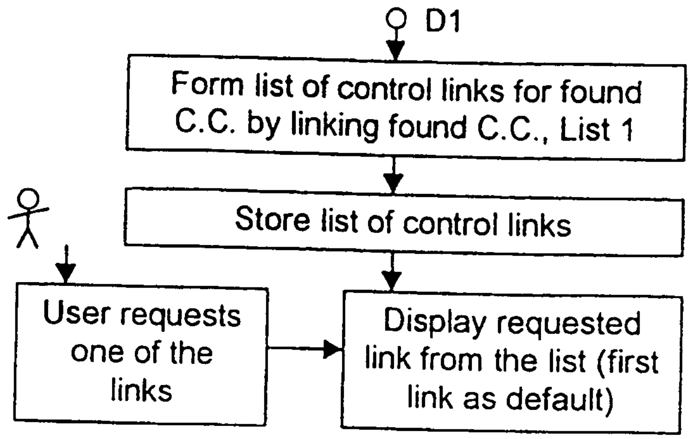

D1
Form list of control links for found C.C. by linking found C.C., List 1
Store list of control links
User requests one of the links
Display requested link from the list (first link as default)

Fig. 11b

Flow chart: Problem solution. Control linking mode started from define user C.C.

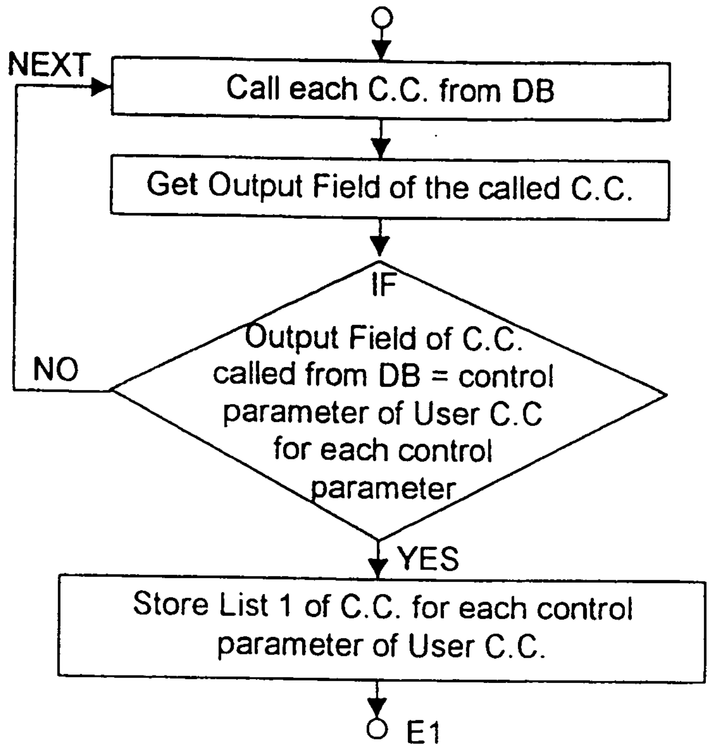


Fig. 12a

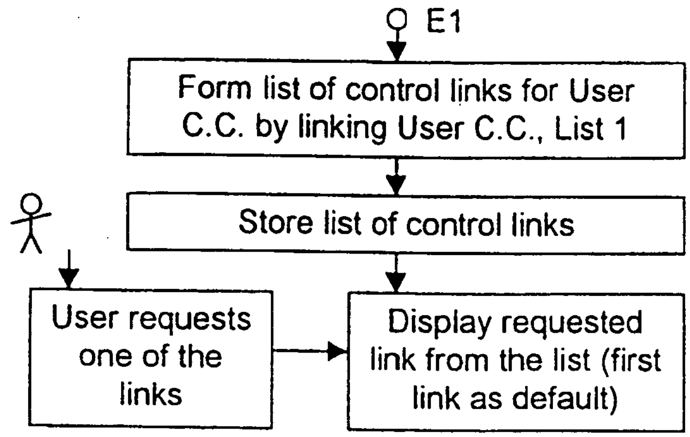

E1
Form list of control links for User C.C. by linking User C.C., List 1
Store list of control links
User requests one of the links
Display requested link from the list (first link as default)

Fig. 12b

Flow chart: Problem solution. Control linking mode started from direct access.

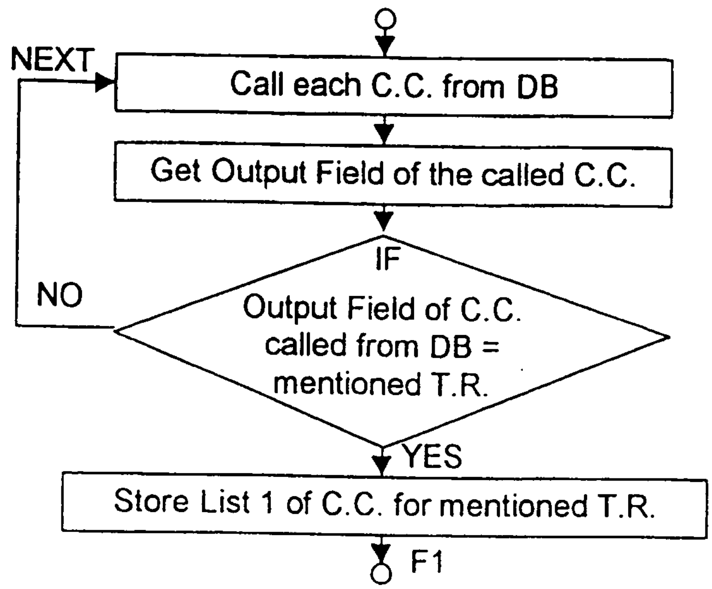


Fig. 13a

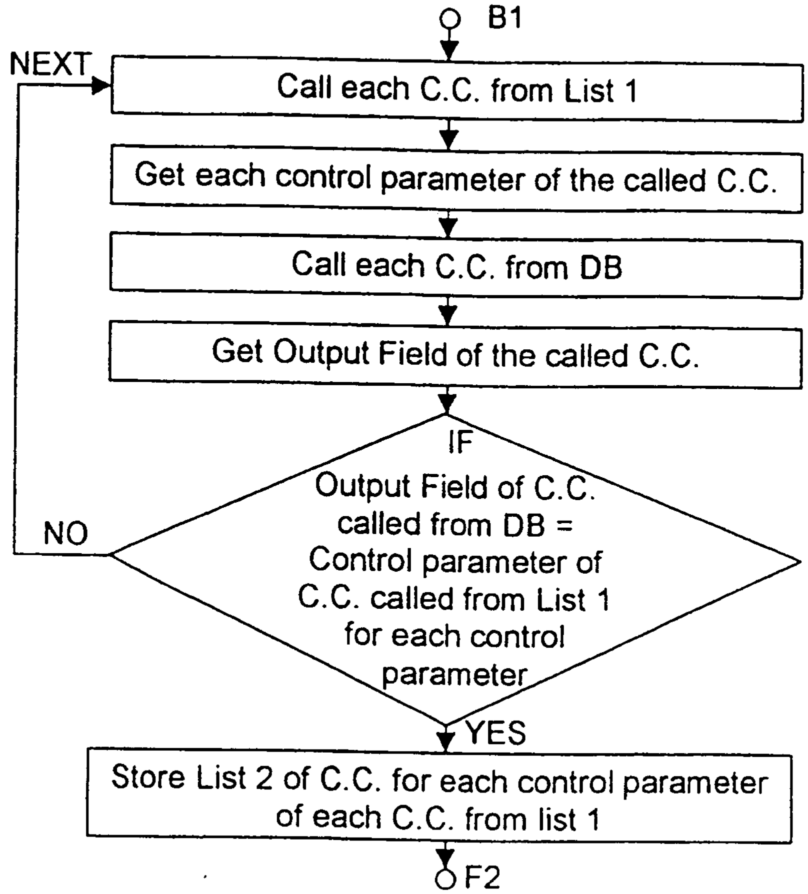

B1
NEXT
Call each C.C. from List 1
Get each control parameter of the called C.C.
Call each C.C. from DB
Get Output Field of the called C.C.
IF
Output Field of C.C. called from DB = Control parameter of C.C. called from List 1 for each control parameter
NO
YES
Store List 2 of C.C. for each control parameter of each C.C. from list 1
F2

Fig. 13b

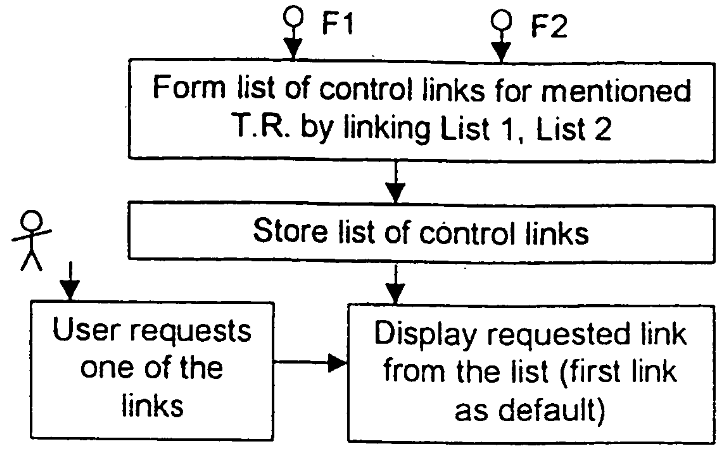

F1
F2
Form list of control links for mentioned T.R. by linking List 1, List 2
Store list of control links
User requests one of the links
Display requested link from the list (first link as default)

Fig. 13c

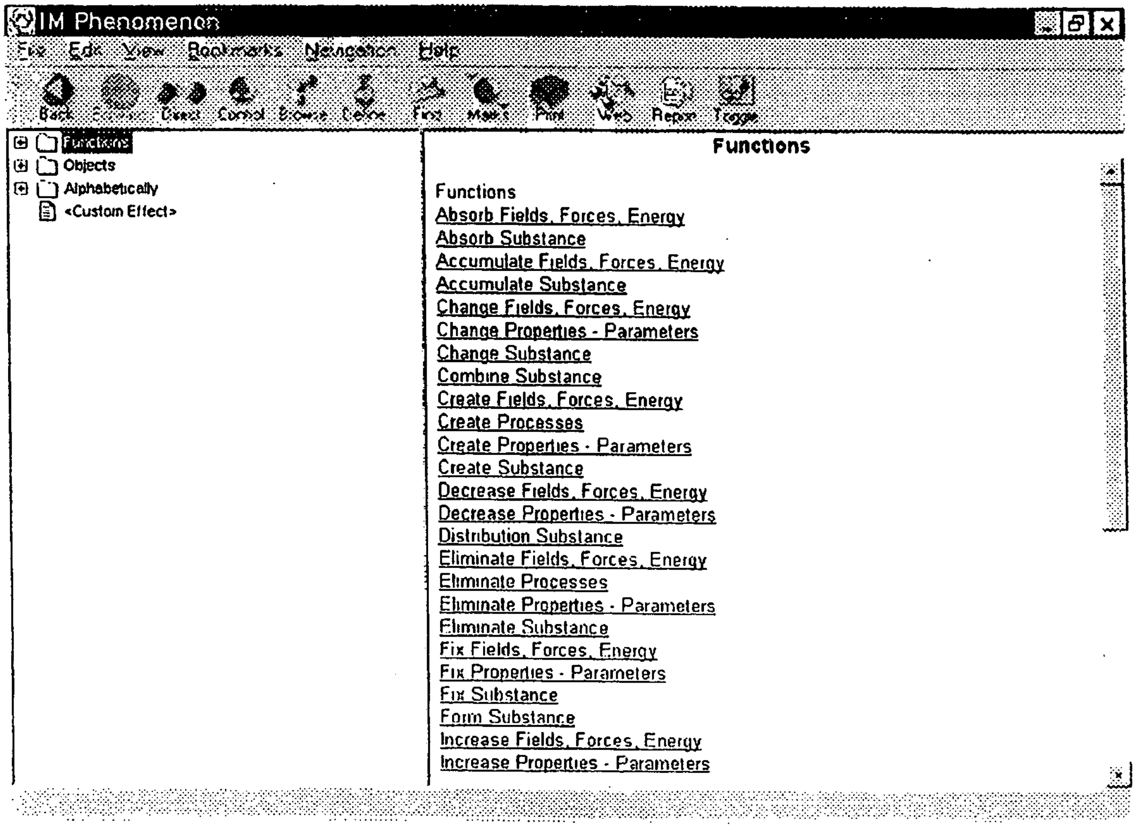

IM Phenomenon
Back
Direct
Control
Browse
Define
Find
Marks
Print
Web
Report
Toggle
Functions
Objects
Alphabetically
<Custom Effect>
Functions
Functions
Absorb Fields, Forces, Energy
Absorb Substance
Accumulate Fields, Forces, Energy
Accumulate Substance
Change Fields, Forces, Energy
Change Properties - Parameters
Change Substance
Combine Substance
Create Fields, Forces, Energy
Create Processes
Create Properties - Parameters
Create Substance
Decrease Fields, Forces, Energy
Decrease Properties - Parameters
Distribution Substance
Eliminate Fields, Forces, Energy
Eliminate Processes
Eliminate Properties - Parameters
Eliminate Substance
Fix Fields, Forces, Energy
Fix Properties - Parameters
Fix Substance
Form Substance
Increase Fields, Forces, Energy
Increase Properties - Parameters

FIG. 14

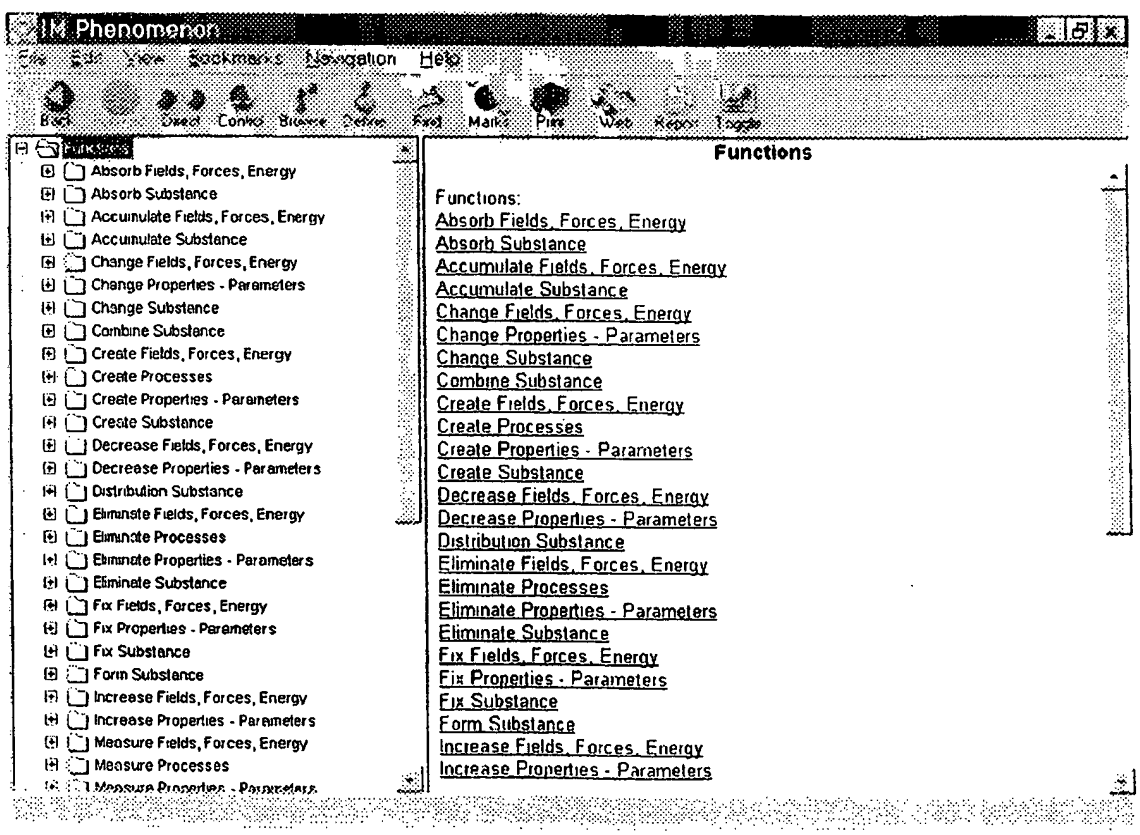

IM Phenomenon
Navigation
Help
Back
Direct
Marks
Print
Web
Toggle
Absorb Fields, Forces, Energy
Absorb Substance
Accumulate Fields, Forces, Energy
Accumulate Substance
Change Fields, Forces, Energy
Change Properties - Parameters
Change Substance
Combine Substance
Create Fields, Forces, Energy
Create Processes
Create Properties - Parameters
Create Substance
Decrease Fields, Forces, Energy
Decrease Properties - Parameters
Distribution Substance
Eliminate Fields, Forces, Energy
Eliminate Processes
Eliminate Properties - Parameters
Eliminate Substance
Fix Fields, Forces, Energy
Fix Properties - Parameters
Fix Substance
Form Substance
Increase Fields, Forces, Energy
Increase Properties - Parameters
Measure Fields, Forces, Energy
Measure Processes
Functions
Functions:
Absorb Fields, Forces, Energy
Absorb Substance
Accumulate Fields, Forces, Energy
Accumulate Substance
Change Fields, Forces, Energy
Change Properties - Parameters
Change Substance
Combine Substance
Create Fields, Forces, Energy
Create Processes
Create Properties - Parameters
Create Substance
Decrease Fields, Forces, Energy
Decrease Properties - Parameters
Distribution Substance
Eliminate Fields, Forces, Energy
Eliminate Processes
Eliminate Properties - Parameters
Eliminate Substance
Fix Fields, Forces, Energy
Fix Properties - Parameters
Fix Substance
Form Substance
Increase Fields, Forces, Energy
Increase Properties - Parameters

FIG. 15

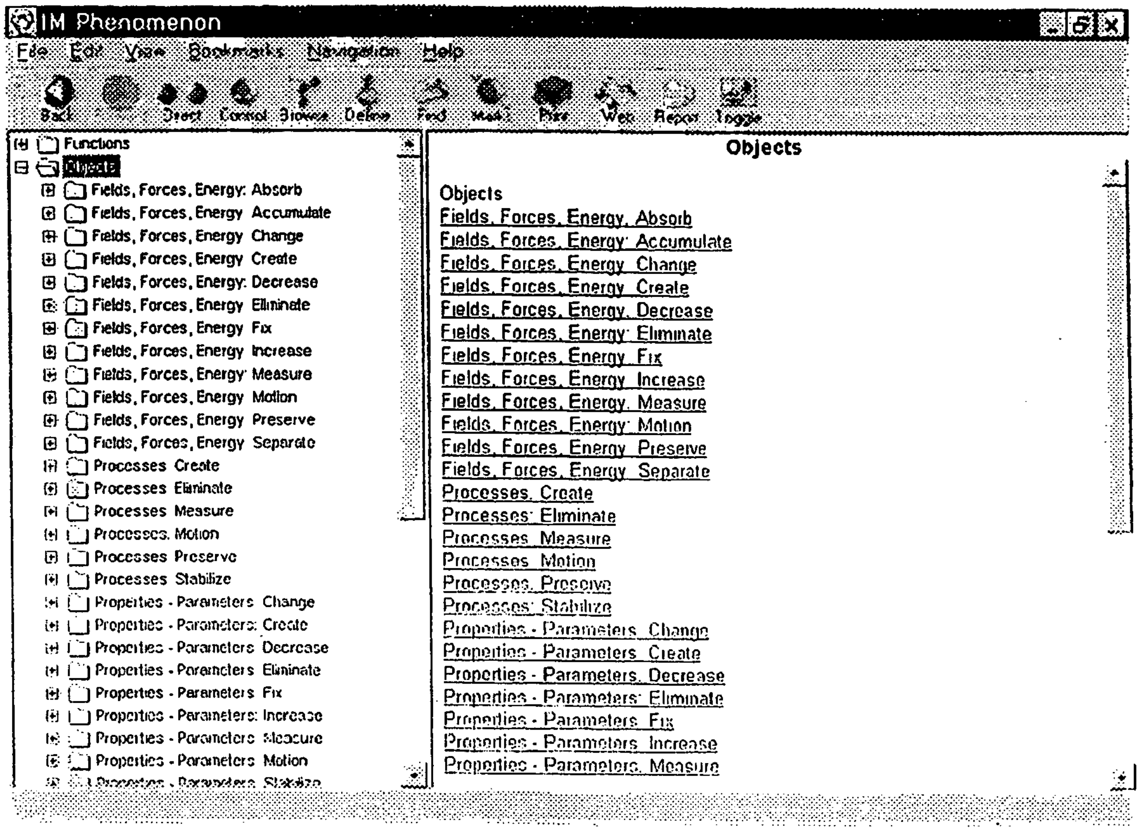

IM Phenomenon
File Edit View Bookmarks Navigation Help
Back Direct Control Browse Define Find Mark Print Web Report Toggle
Functions
Objects
Objects
Objects
Fields, Forces, Energy: Absorb
Fields, Forces, Energy: Accumulate
Fields, Forces, Energy: Change
Fields, Forces, Energy: Create
Fields, Forces, Energy: Decrease
Fields, Forces, Energy: Eliminate
Fields, Forces, Energy: Fix
Fields, Forces, Energy: Increase
Fields, Forces, Energy: Measure
Fields, Forces, Energy: Motion
Fields, Forces, Energy: Preserve
Fields, Forces, Energy: Separate
Processes: Create
Processes: Eliminate
Processes: Measure
Processes: Motion
Processes: Preserve
Processes: Stabilize
Properties - Parameters: Change
Properties - Parameters: Create
Properties - Parameters: Decrease
Properties - Parameters: Eliminate
Properties - Parameters: Fix
Properties - Parameters: Increase
Properties - Parameters: Measure
Properties - Parameters: Motion

FIG. 16

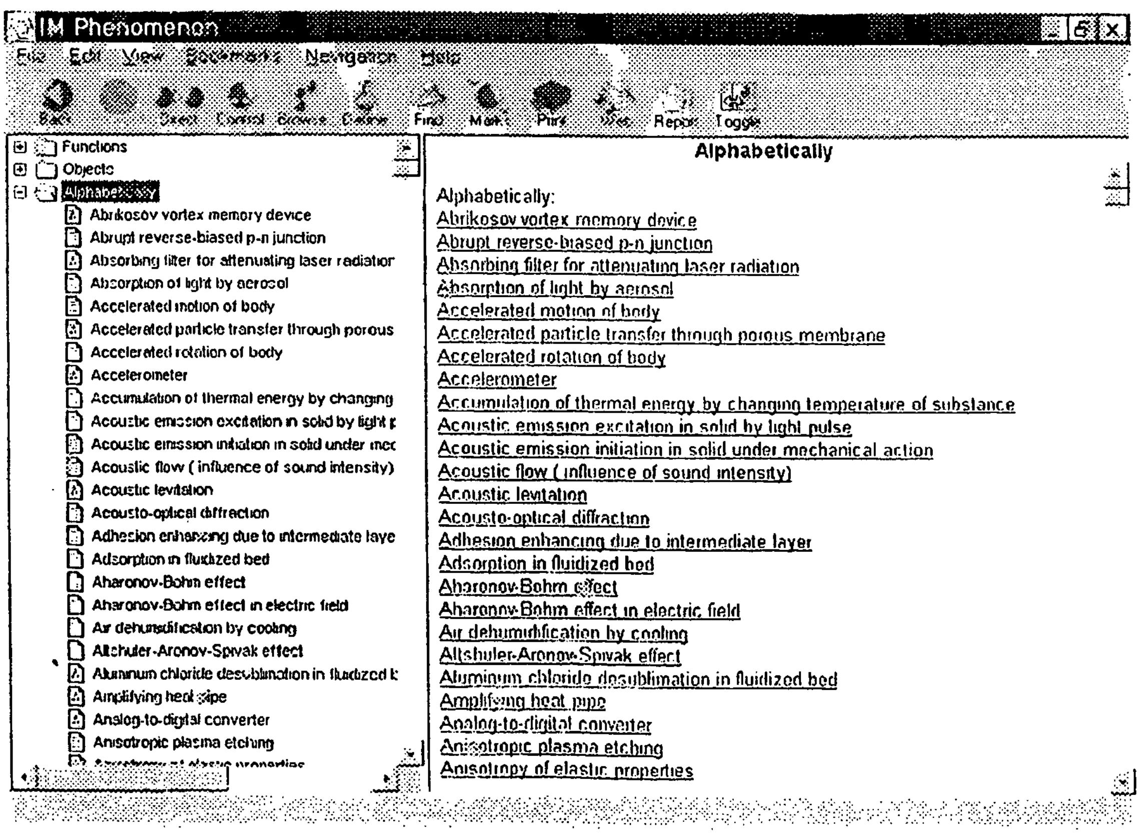

IM Phenomenon
File Edit View Bookmarks Navigation Help
Back Direct Control Browse Define Find Mark Print Web Report Toggle
Functions
Objects
Alphabetically
Alphabetically
Alphabetically:
Abrikosov vortex memory device
Abrupt reverse-biased p-n junction
Absorbing filter for attenuating laser radiation
Absorption of light by aerosol
Accelerated motion of body
Accelerated particle transfer through porous membrane
Accelerated rotation of body
Accelerometer
Accumulation of thermal energy by changing temperature of substance
Acoustic emission excitation in solid by light pulse
Acoustic emission initiation in solid under mechanical action
Acoustic flow (influence of sound intensity)
Acoustic levitation
Acousto-optical diffraction
Adhesion enhancing due to intermediate layer
Adsorption in fluidized bed
Aharonov-Bohm effect
Aharonov-Bohm effect in electric field
Air dehumidification by cooling
Altshuler-Aronov-Spivak effect
Aluminum chloride desublimation in fluidized bed
Amplifying heat pipe
Analog-to-digital converter
Anisotropic plasma etching
Anisotropy of elastic properties

FIG. 17

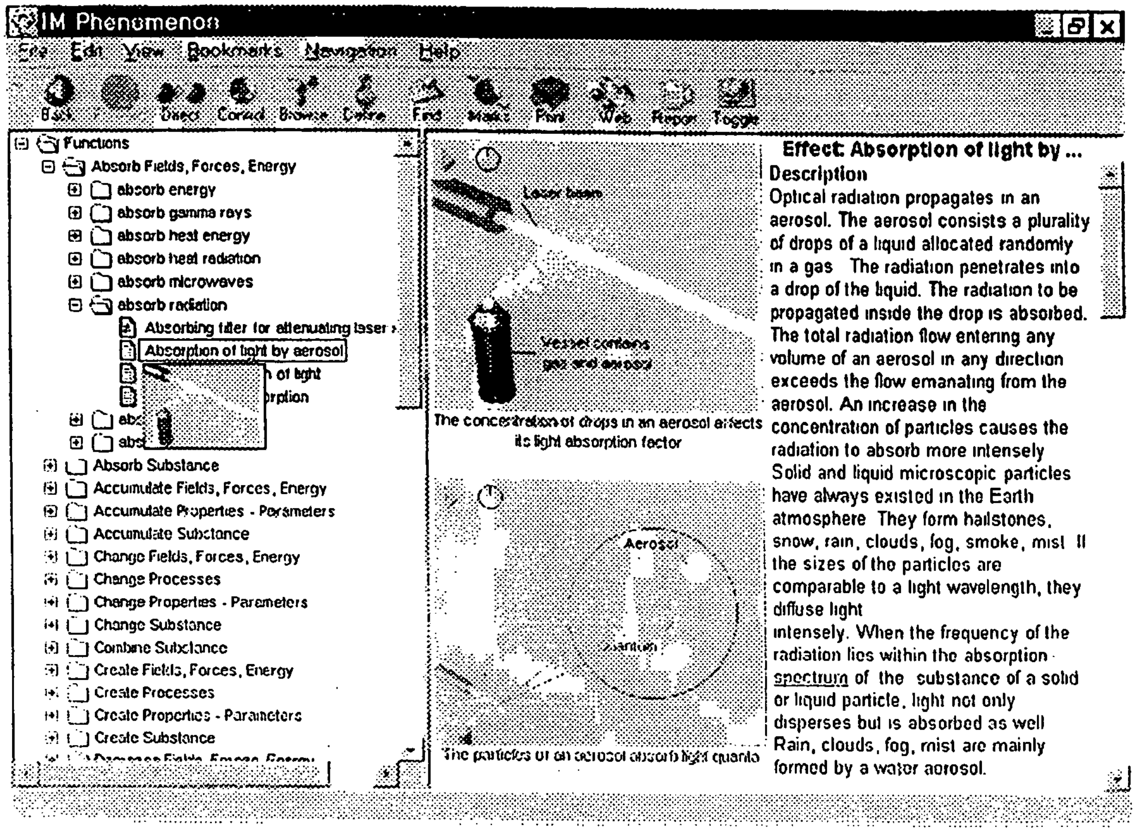

IM Phenomenon
File Edit View Bookmarks Navigation Help
Functions
Absorb Fields, Forces, Energy
absorb energy
absorb gamma rays
absorb heat energy
absorb heat radiation
absorb microwaves
absorb radiation
Absorbing filter for attenuating laser
Absorption of light by aerosol
Absorb Substance
Accumulate Fields, Forces, Energy
Accumulate Properties - Parameters
Accumulate Substance
Change Fields, Forces, Energy
Change Processes
Change Properties - Parameters
Change Substance
Combine Substance
Create Fields, Forces, Energy
Create Processes
Create Properties - Parameters
Create Substance
Laser beam
The concentration of drops in an aerosol affects its light absorption factor
Aerosol
The particles of an aerosol absorb light quanta
Effect: Absorption of light by ...
Description
Optical radiation propagates in an aerosol. The aerosol consists a plurality of drops of a liquid allocated randomly in a gas The radiation penetrates into a drop of the liquid. The radiation to be propagated inside the drop is absorbed. The total radiation flow entering any volume of an aerosol in any direction exceeds the flow emanating from the aerosol. An increase in the concentration of particles causes the radiation to absorb more intensely Solid and liquid microscopic particles have always existed in the Earth atmosphere They form hailstones, snow, rain, clouds, fog, smoke, mist If the sizes of the particles are comparable to a light wavelength, they diffuse light intensely. When the frequency of the radiation lies within the absorption spectrum of the substance of a solid or liquid particle, light not only disperses but is absorbed as well Rain, clouds, fog, mist are mainly formed by a water aerosol.

FIG. 18

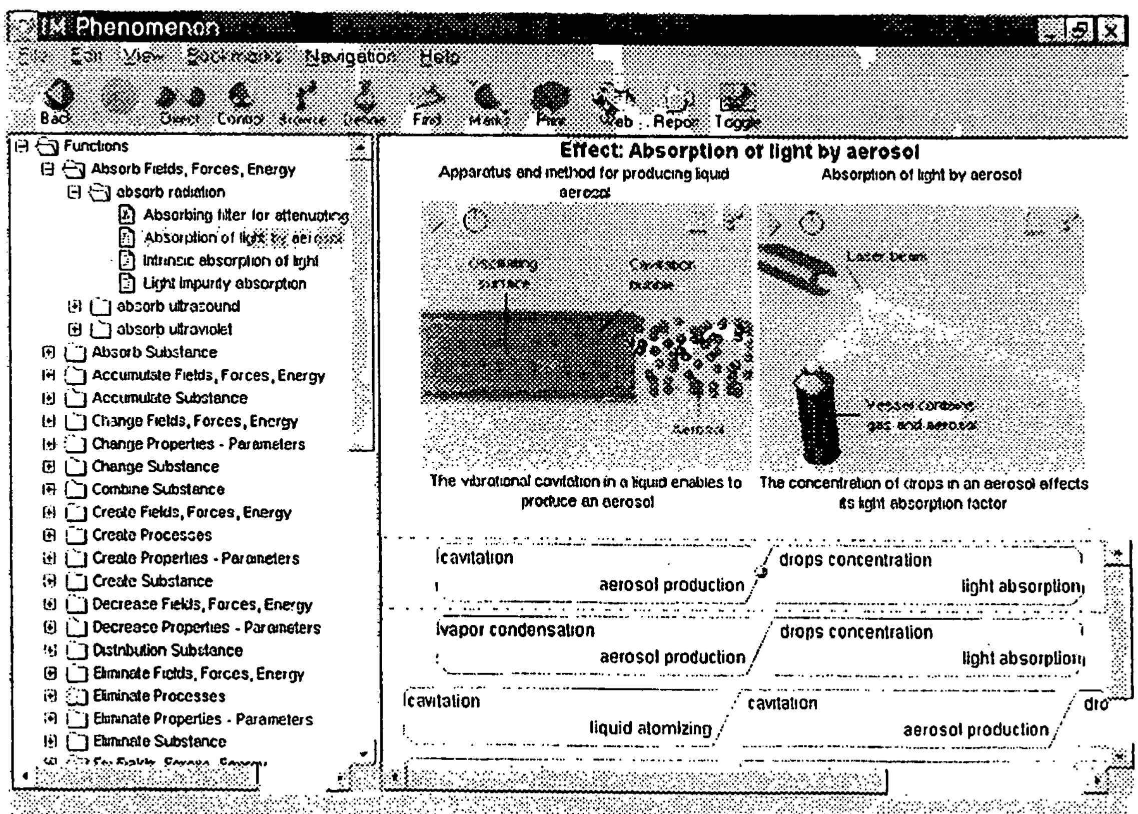

IM Phenomenon
Navigation Help
Back
Find Print Web Report Toggle
Functions
Absorb Fields, Forces, Energy
absorb radiation
Absorbing filter for attenuating
Absorption of light by aerosol
Intrinsic absorption of light
Light impurity absorption
absorb ultrasound
absorb ultraviolet
Absorb Substance
Accumulate Fields, Forces, Energy
Accumulate Substance
Change Fields, Forces, Energy
Change Properties - Parameters
Change Substance
Combine Substance
Create Fields, Forces, Energy
Create Processes
Create Properties - Parameters
Create Substance
Decrease Fields, Forces, Energy
Decrease Properties - Parameters
Distribution Substance
Eliminate Fields, Forces, Energy
Eliminate Processes
Eliminate Properties - Parameters
Eliminate Substance
Effect: Absorption of light by aerosol
Apparatus and method for producing liquid aerosol
Absorption of light by aerosol
Laser beam
The vibrational cavitation in a liquid enables to produce an aerosol
The concentration of drops in an aerosol effects its light absorption factor
cavitation
aerosol production
drops concentration
light absorption
vapor condensation
aerosol production
drops concentration
light absorption
cavitation
liquid atomizing
cavitation
aerosol production

FIG. 19

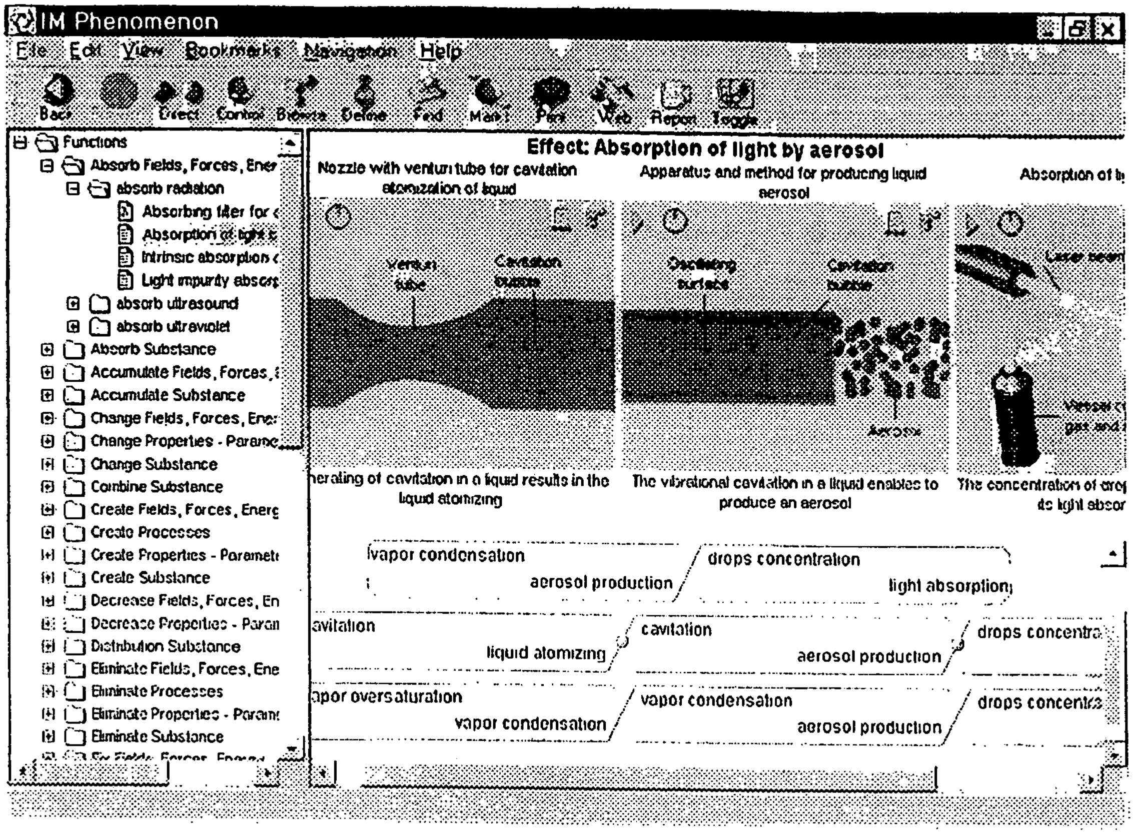

IM Phenomenon
File Edit View Bookmarks Navigation Help
Back Direct Control Browse Define Find Mark Print Web Report Toggle
Functions
Absorb Fields, Forces, Ener
absorb radiation
absorb ultrasound
absorb ultraviolet
Absorb Substance
Accumulate Substance
Change Substance
Combine Substance
Create Processes
Create Substance
Distribution Substance
Eliminate Processes
Eliminate Substance
Effect: Absorption of light by aerosol
Nozzle with venturi tube for cavitation atomization of liquid
Apparatus and method for producing liquid aerosol
The vibrational cavitation in a liquid enables to produce an aerosol
vapor condensation
aerosol production
drops concentration
liquid atomizing
cavitation

FIG. 20

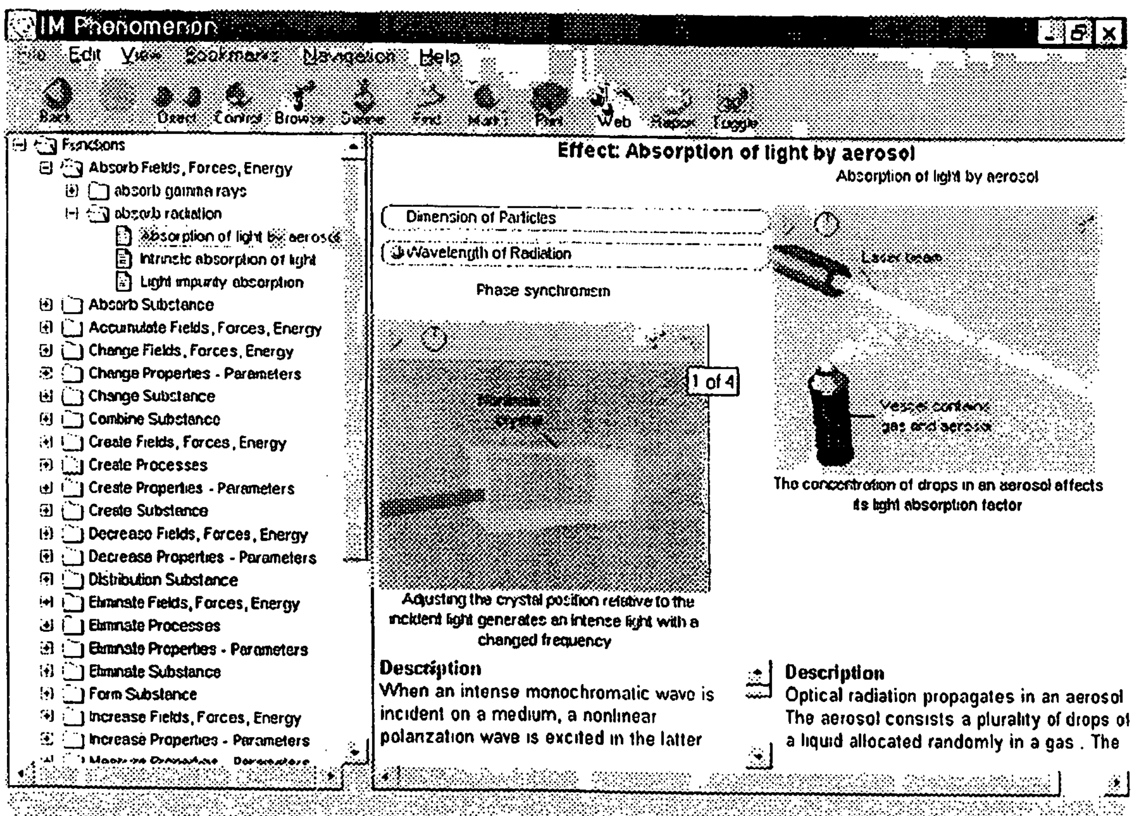

IM Phenomenon
Edit View Bookmarks Navigation Help
Back Direct Control Browse Define Find Mark Print Web Report Toggle
Functions
Absorb Fields, Forces, Energy
absorb gamma rays
absorb radiation
Absorption of light by aerosol
Intrinsic absorption of light
Light impurity absorption
Absorb Substance
Accumulate Fields, Forces, Energy
Change Fields, Forces, Energy
Change Properties - Parameters
Change Substance
Combine Substance
Create Fields, Forces, Energy
Create Processes
Create Properties - Parameters
Create Substance
Decrease Fields, Forces, Energy
Decrease Properties - Parameters
Distribution Substance
Eliminate Fields, Forces, Energy
Eliminate Processes
Eliminate Properties - Parameters
Eliminate Substance
Form Substance
Increase Fields, Forces, Energy
Increase Properties - Parameters
Effect: Absorption of light by aerosol
Absorption of light by aerosol
Dimension of Particles
Wavelength of Radiation
Phase synchronism
1 of 4
The concentration of drops in an aerosol affects its light absorption factor
Adjusting the crystal position relative to the incident light generates an intense light with a changed frequency
Description
When an intense monochromatic wave is incident on a medium, a nonlinear polarization wave is excited in the latter
Description
Optical radiation propagates in an aerosol The aerosol consists a plurality of drops of a liquid allocated randomly in a gas . The

FIG. 21

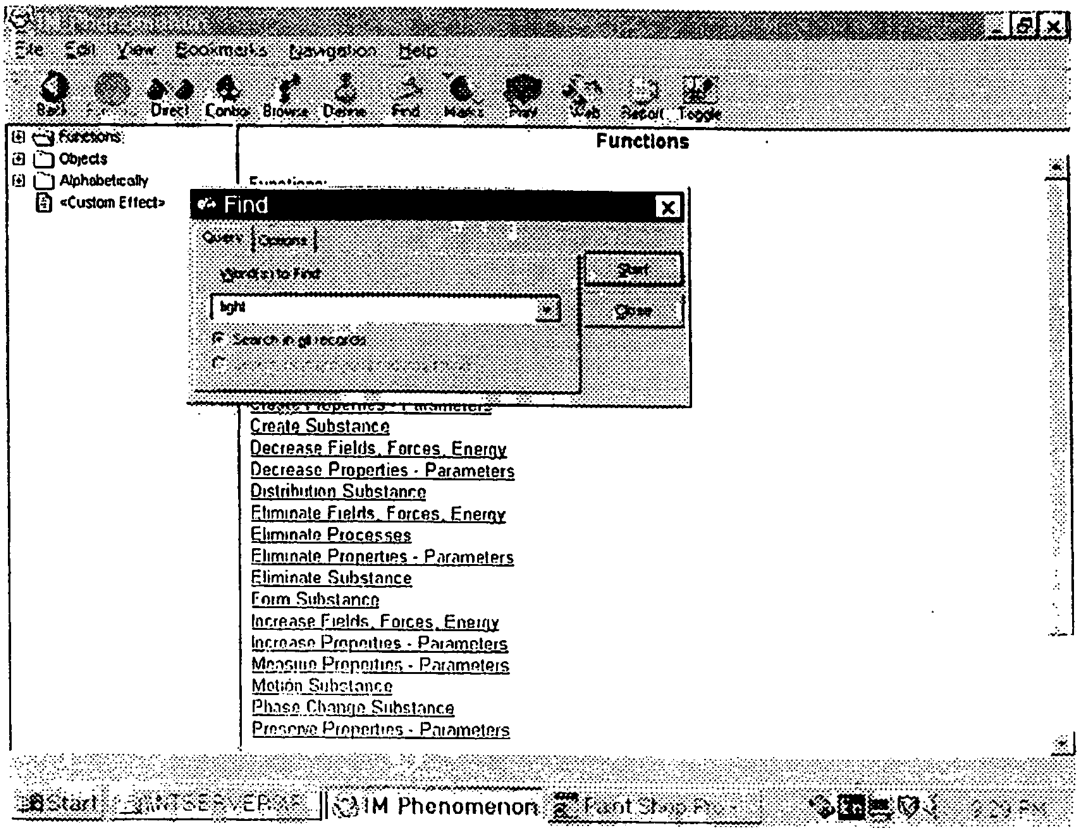

File Edit View Bookmarks Navigation Help
Back Direct Contra Browse Define Find Marks Print Web Recall Toggle
Functions
Objects
Alphabetically
<Custom Effect>
Functions
Find
Query Options
Start
Close
light
Search in all records
Create Substance
Decrease Fields, Forces, Energy
Decrease Properties - Parameters
Distribution Substance
Eliminate Fields, Forces, Energy
Eliminate Processes
Eliminate Properties - Parameters
Eliminate Substance
Form Substance
Increase Fields, Forces, Energy
Increase Properties - Parameters
Measure Properties - Parameters
Motion Substance
Phase Change Substance
Preserve Properties - Parameters
Start
IM Phenomenon

FIG. 22

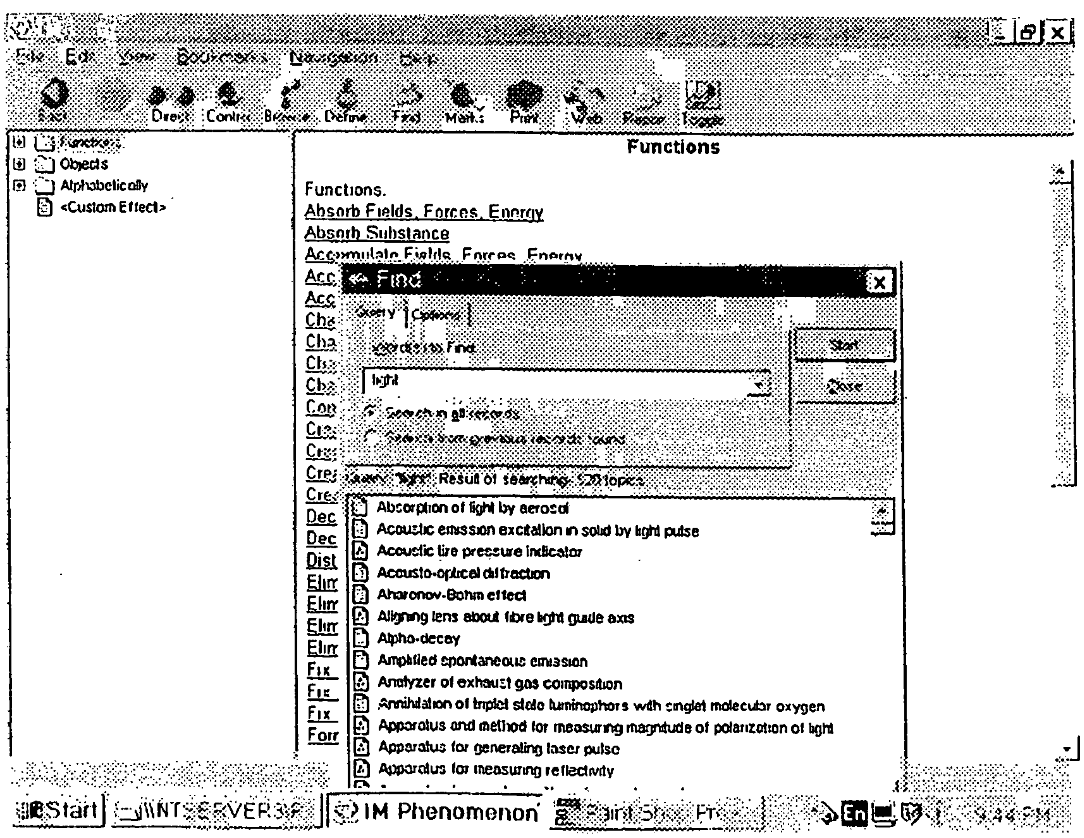
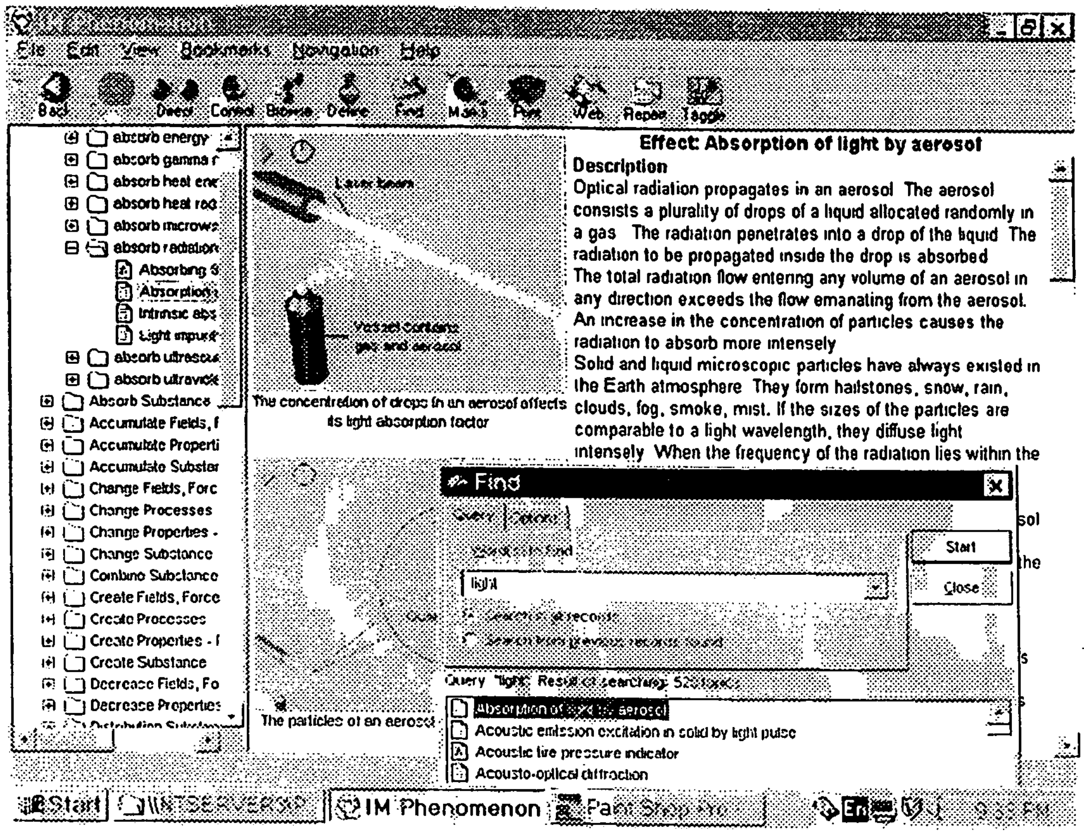
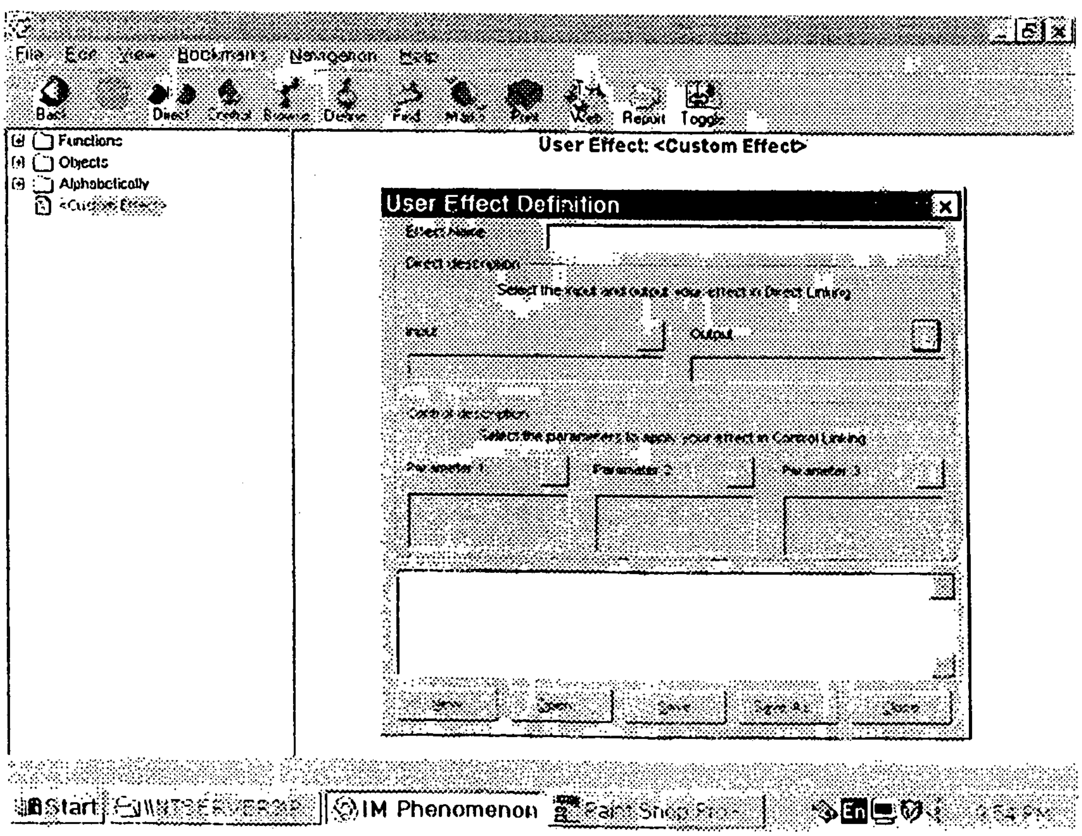

File Edit View Bookmarks Navigation Help
Back Direct Contra Browse Define Find Marks Print Web Recall Toggle
Functions
Objects
Alphabetically
<Custom Effect>
Functions
Functions.
Absorb Fields, Forces, Energy
Absorb Substance
Accumulate Fields, Forces, Energy
Find
Query Options
Start
Close
light
Search in all records
Absorption of light by aerosol
Acoustic emission excitation in solid by light pulse
Acoustic tire pressure indicator
Acousto-optical diffraction
Aharonov-Bohm effect
Aligning lens about fibre light guide axis
Alpha-decay
Amplified spontaneous emission
Analyzer of exhaust gas composition
Annihilation of triplet state luminophors with singlet molecular oxygen
Apparatus and method for measuring magnitude of polarization of light
Apparatus for generating laser pulse
Apparatus for measuring reflectivity
Start
IM Phenomenon

FIG. 23



File Edit View Bookmarks Navigation Help
Effect: Absorption of light by aerosol
Description
Optical radiation propagates in an aerosol The aerosol consists a plurality of drops of a liquid allocated randomly in a gas The radiation penetrates into a drop of the liquid The radiation to be propagated inside the drop is absorbed
The total radiation flow entering any volume of an aerosol in any direction exceeds the flow emanating from the aerosol.
An increase in the concentration of particles causes the radiation to absorb more intensely
Solid and liquid microscopic particles have always existed in the Earth atmosphere They form hailstones, snow, rain, clouds, fog, smoke, mist. If the sizes of the particles are comparable to a light wavelength, they diffuse light intensely When the frequency of the radiation lies within the
The concentration of drops in an aerosol affects its light absorption factor
The particles of an aerosol
Find
Start
Close
light
Absorption of light by aerosol
Acoustic emission excitation in solid by light pulse
Acoustic fire pressure indicator
Acousto-optical diffraction
Start
IM Phenomenon

FIG. 24



Functions
Objects
Alphabetically
User Effect: <Custom Effect>
User Effect Definition
Start
IM Phenomenon

FIG. 25

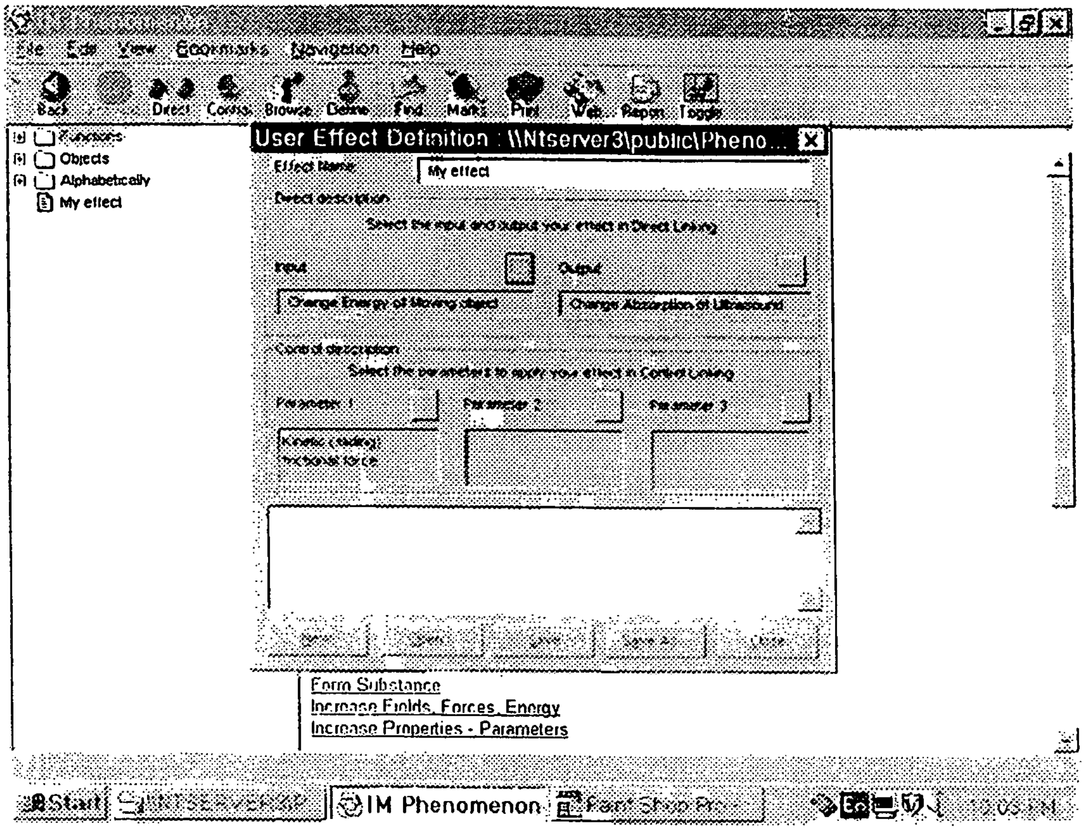

User Effect Definition : \\Ntserver3\public\Pheno...
Effect Name
My effect
Input
Change Energy of Moving object
Change Absorption of Ultrasound
Functions
Objects
Alphabetically
My effect
Form Substance
Increase Fields, Forces, Energy
Increase Properties - Parameters
Start
IM Phenomenon

FIG. 26

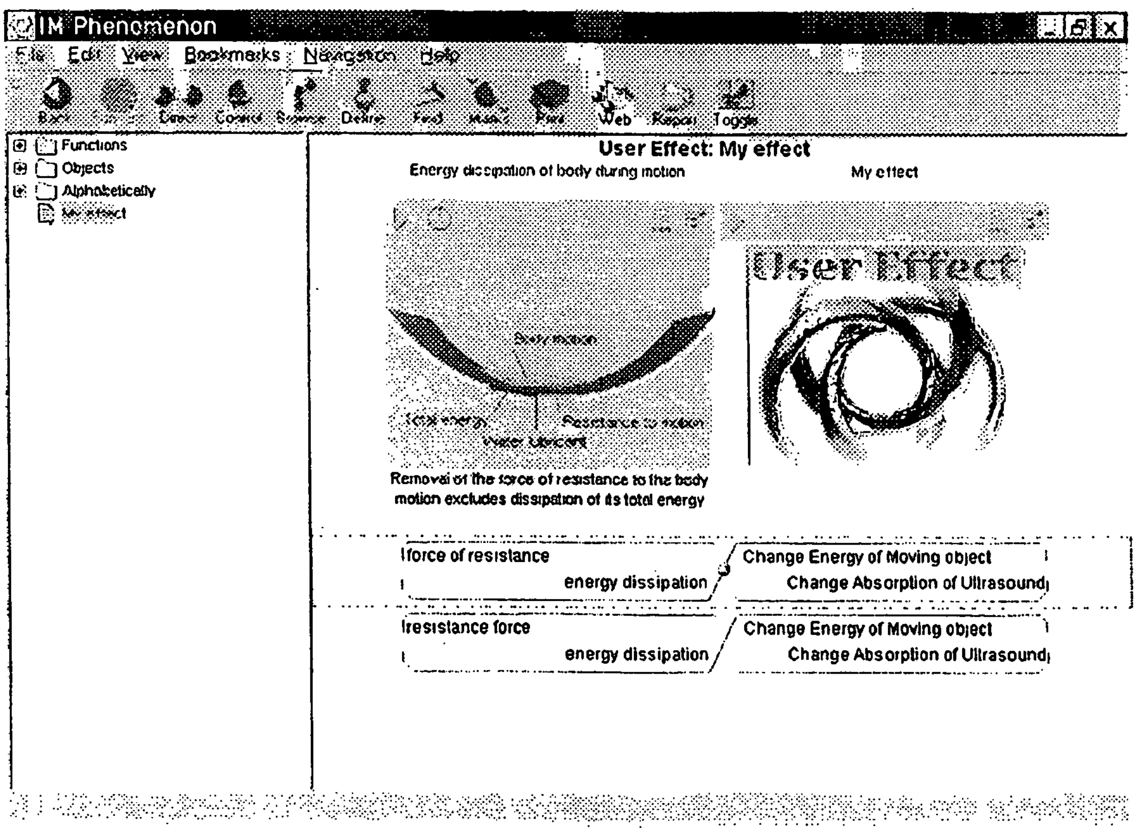

IM Phenomenon
File
Edit
View
Bookmarks
Navigation
Help
Functions
Objects
Alphabetically
User Effect: My effect
Energy dissipation of body during motion
My effect
User Effect
Removal of the force of resistance to the body motion excludes dissipation of its total energy
force of resistance
energy dissipation
Change Energy of Moving object
Change Absorption of Ultrasound
resistance force
energy dissipation
Change Energy of Moving object
Change Absorption of Ultrasound

FIG. 27

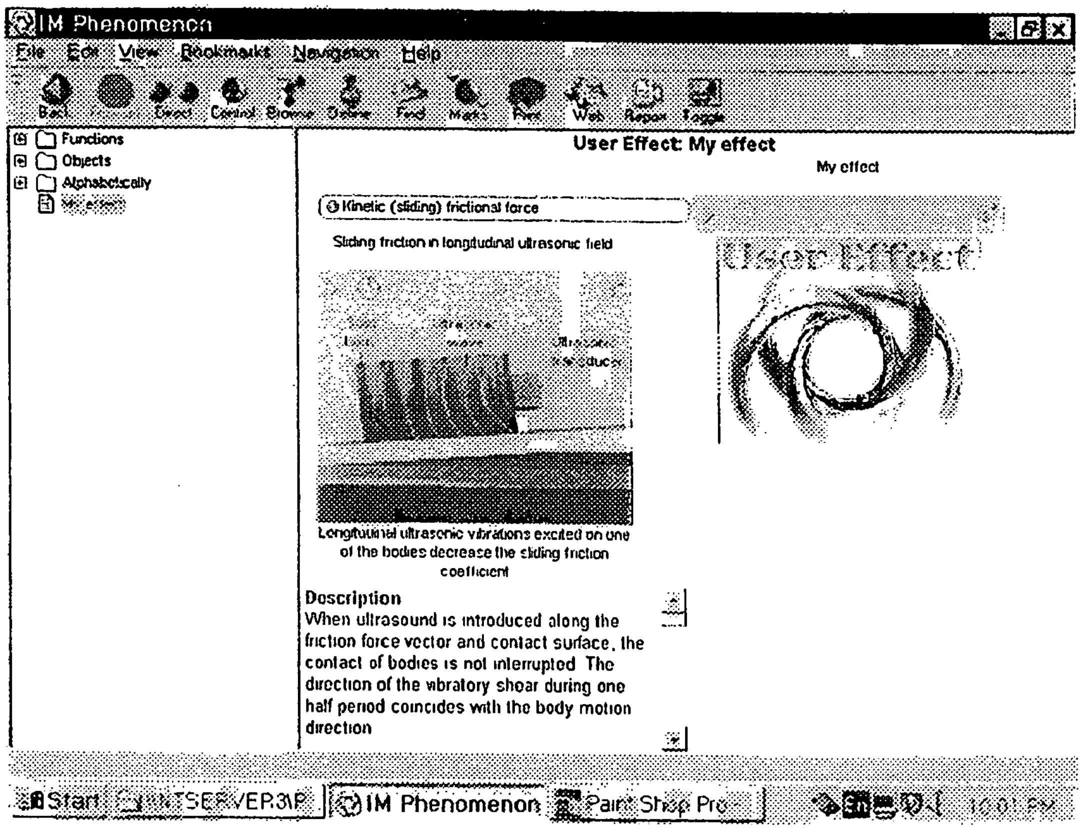

IM Phenomenon
File Edit View Bookmarks Navigation Help
Back Control Find Marks Print Web Toggle
Functions
Objects
Alphabetically
User Effect: My effect
My effect
Kinetic (sliding) frictional force
Sliding friction in longitudinal ultrasonic field
User Effect
Longitudinal ultrasonic vibrations excited on one of the bodies decrease the sliding friction coefficient
Description
When ultrasound is introduced along the friction force vector and contact surface, the contact of bodies is not interrupted. The direction of the vibratory shear during one half period coincides with the body motion direction
Start
IM Phenomenon
Paint Shop Pro

FIG. 28

INTERNATIONAL SEARCH REPORT

International application No.
PCT/US98/21126

A. CLASSIFICATION OF SUBJECT MATTER

IPC(6) :G06F 17/50
US CL :364/488, 489, 578
According to International Patent Classification (IPC) or to both national classification and IPC

B. FIELDS SEARCHED

Minimum documentation searched (classification system followed by classification symbols)

U.S. : 364/488, 489, 578

Documentation searched other than minimum documentation to the extent that such documents are included in the fields searched

NONE

Electronic data base consulted during the international search (name of data base and, where practicable, search terms used)

APS, DIALOG

C. DOCUMENTS CONSIDERED TO BE RELEVANT

Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
A	US 5,006,991 A [OHCOSHI et al] 9 April 1991, entire document.	1-17
A	US 5,544,067 A [ROSTOKER et al] 6 August 1996, entire document.	1-17

☐ Further documents are listed in the continuation of Box C. ☐ See patent family annex.

* Special categories of cited documents:

"A" document defining the general state of the art which is not considered to be of particular relevance

"E" earlier document published on or after the international filing date

"L" document which may throw doubts on priority claim(s) or which is cited to establish the publication date of another citation or other special reason (as specified)

"O" document referring to an oral disclosure, use, exhibition or other means

"P" document published prior to the international filing date but later than the priority date claimed

"T" later document published after the international filing date or priority date and not in conflict with the application but cited to understand the principle or theory underlying the invention

"X" document of particular relevance; the claimed invention cannot be considered novel or cannot be considered to involve an inventive step when the document is taken alone

"Y" document of particular relevance; the claimed invention cannot be considered to involve an inventive step when the document is combined with one or more other such documents, such combination being obvious to a person skilled in the art

"&" document member of the same patent family

Date of the actual completion of the international search

17 DECEMBER 1998

Date of mailing of the international search report

22 FEB 1999

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